BELL QUARTERLY

VOL. XIV

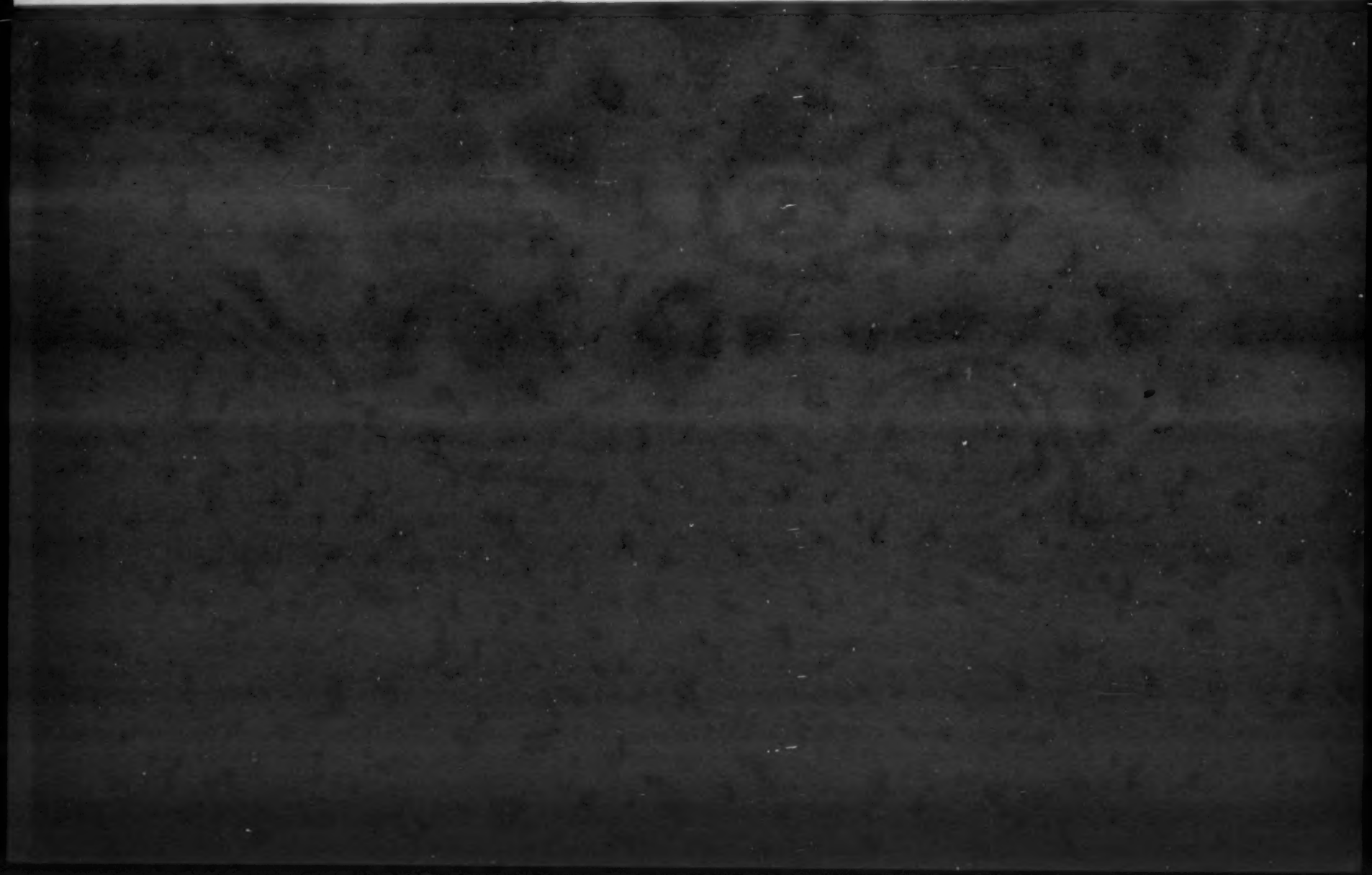
"OTHER APPROPRIATE MEANS"

THOMAS A. WATSON'S CONTRIBUTIONS TO TELEPHONY

THE CHANGING YEARS AS SEEN FROM THE SWITCHBOARD

THE EFFECT OF IMMIGRATION ON POPULATION GROWTH AND CHARACTER

AMERICAN TELEPHONE & TELEGRAPH CO.



BELL TELEPHONE QUARTERLY

A Medium of Suggestion and a Record of Progress

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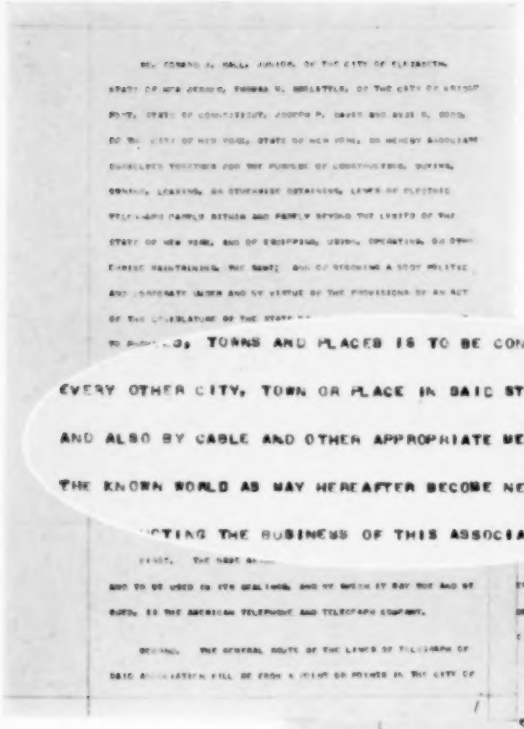


TOWNS AND PLACES IS TO BE CONNECTED WI...
EVERY OTHER CITY, TOWN OR PLACE IN SAID STATES AND COUNTRIES,
AND ALSO BY CABLE AND OTHER APPROPRIATE MEANS WITH THE REST OF
THE KNOWN WORLD AS MAY HEREAFTER BECOME NECESSARY OR DESIRABLE
...CTING THE BUSINESS OF THIS ASSOCIATION .

Page 1 of the Certificate of Incorporation of the American Telephone and Telegraph Company. In the third line from the bottom occurs the formal declaration of the present corporate name.

The fourth and last page of the Certificate. On it, beside their respective seals, may be seen the signatures of the four incorporators: Edward J. Hall, Jr., T. B. Doolittle, Joseph P. Davis, and Amzi S. Dodd.

PAGES FROM HISTORY

TWO OF THE FOUR SHEETS OF THE CERTIFICATE WHICH CREATED THE AMERICAN TELEPHONE AND TELEGRAPH COMPANY FIFTY YEARS AGO LAST MONTH. IN THE OVAL, WHICH REPRODUCES A FEW LINES FROM THE THIRD PAGE, MAY BE READ THE PHRASE WHICH PROVIDES THE TITLE FOR THE ARTICLE BEGINNING ON THE OPPOSITE PAGE.

"Other Appropriate Means"

"And it is further declared and certified that the general routes of the lines of this association in addition to those hereinbefore described or designated, will connect one or more points in each and every city, town or place in said State and in each and every other of the United States, and in Canada and Mexico; and each and every of said cities, towns and places is to be connected with each and every other city, town or place in said states and countries, and also by cable and other appropriate means with the rest of the known world, as may hereafter become necessary or desirable in conducting the business of this association."

The "association" referred to in the paragraph just quoted was the American Telephone and Telegraph Company, and the paragraph occurs in the Certificate of Incorporation for the Company, which was executed just fifty years ago, on February 28, 1885. On March 3 it was filed and recorded in the office of the Secretary of State at Albany, N. Y. It was signed by Edward J. Hall, Jr., T. B. Doolittle, Jos. P. Davis and A. S. Dodd, who held equally the 1,000 shares which comprised the capital stock of the newly created organization.

"Other appropriate means!" What hopeful words they were! What absurd words they must have seemed at the time to almost anyone not inspired with the belief that the telephone principle discovered by Alexander Graham Bell held boundless possibilities of usefulness for mankind. And what prophetic words they seem as we read them again, remembering that the recent inauguration of telephone service between this country and Japan left only three countries in all the world with more than 100,000 telephones not united by telephone service with the United States.

In this semi-centennial year it is interesting to recall the situation that existed in telephony at the time this memorable

paragraph was written, and to sketch the dramatic story of a vision realized. Only nine years had passed since the historic moment when Bell had called "Mr. Watson, come here, I want you," and his assistant, Thomas A. Watson, in a distant room had heard the summons—by telephone. In the United States there were not more than 160,000 telephone instruments, operated by various companies that were struggling with the discouraging problem of promoting local service.

To make telephone service possible between places where local service was being given was an inevitable ambition of the telephone pioneers, and there were experiments to that end. But such experiments, when involving distances of more than 50 or 60 miles, ended in failure until the possibilities of metallic circuits and hard-drawn copper wire were discovered. When the iron wire circuit with grounded return was superseded by an all-copper two-wire circuit, the experiments met with increasing success, and in 1881 a line was opened for service between Boston, Mass., and Providence, R. I.

The usefulness, both real and potential, of this Boston-Providence line encouraged its extension through New Haven, Conn., to New York City. Various companies along its route constructed the different sections. By the time it reached New York in 1884, the necessity for similar lines to interconnect other cities was apparent. It was equally apparent, however, that the local companies themselves, occupied with their immediate local problems, could not finance, build and operate them.

So it was that the American Telephone and Telegraph Company came into being, its hopeful purpose being to provide "appropriate means" whereby "each and every of said cities . . . is to be connected with each and every other city . . . and with the rest of the known world."

The new Company's first accomplishment was the completion of a line between New York and Philadelphia which had been started by the American Bell Telephone Company. E. J.

Hall, Jr., first General Manager of the A. T. and T. Company, noted in his diary for January 2, 1886:

"Six wires completed between New York and Philadelphia today."

It was then discovered that whatever was spoken over any one pair of the wires could be heard over all pairs at the distant terminal. This "crosstalk" was corrected by installing a system for transposing or changing the positions of the wires on the crossarms at certain poles along the line—one of the earliest of the "appropriate means" developed to aid in the extension of long distance service. The diary for January 21, 1886, states:

"Tested Philadelphia wires and had excellent results. The six wires are now O.K."

As soon as the new line reached Philadelphia, work was begun to extend it to Washington. At about the same time a line was started from New York to Albany, and the old line to Boston was reconstructed with a view to obtaining improvements in operation.

During the succeeding years the American Telephone and Telegraph Company continued building on an extensive scale. The first lines from the East reached Chicago in 1892, St. Louis in 1896, Minneapolis a year later and Kansas City in 1898. At the same time other lines were being built through the North-eastern states and branch lines were being extended from important switching points to comparatively near-by cities.

At the time when it appeared as if the limits to long distance telephone service had been reached, an important discovery made possible its further extension. This was the principle of line "loading" to reduce the amount of energy attenuation, which was demonstrated in 1900, the same year in which the A. T. and T. Company replaced the American Bell Telephone Company as the headquarters Company of the Bell System. The next year witnessed the field installations of loading coils

on long distance circuits. Their use greatly increased the range of speech transmission, and by the Fall of 1911 there were circuits from the Atlantic Seaboard reaching westward as far as Denver.

Even before the close of the century the growth of telephone plant resulting from the demand for local service had created a serious problem for telephone engineers. The congestion of wires in cities and towns had become so great that local ordinances were being passed demanding the elimination of pole lines along principal streets. Accordingly, methods were devised to place many of the wires used for local service in cable, and by 1900 the local companies were beginning to use this type of construction on an extensive scale.

While cable could be used satisfactorily for service to near-by points, the electrical energy losses involved formed a barrier to its employment in the long distance plant. By 1910, however, sufficient progress had been made in reducing the losses of electrical energy in long distance cables to enable the construction of the first telephone cable line over 100 miles long to be undertaken. Completely underground, it was routed from Boston through Providence, Hartford, New Haven, New York, Philadelphia and Baltimore. It was completed between Boston and Washington in 1914.

Transcontinental Telephony

Just twenty years ago the first transcontinental telephone line was placed in public service. With the stringing of the final span in the new line, a 3,600 mile link of slender copper wires joined the Atlantic Seaboard with the Pacific Coast, and made voice-to-voice contacts possible within a matter of minutes.

It was an achievement that was recognized as a tremendous forward step in the development of the communications art. Impressive ceremonies marked the inauguration of the new line.

In a statement made at the time, Mr. Theodore N. Vail, then President of the American Telephone and Telegraph Company, said: "This telephone line is part of the Bell System of 21 million miles of wire connecting 9 million telephone stations located everywhere throughout the United States and giving to the American people telephone service unparalleled among the nations of the earth."

With the opening of the line, a telephone service nation-wide in its extent came into being. Since then the number of telephones interconnected by the Bell System has grown from 9 million to 17 million. Transmission has been improved. Speed of service, which even as late as 1925 was twenty minutes on New York-San Francisco calls, has now been reduced to less than two minutes. When the line was opened, a three-minute conversation between New York and San Francisco cost $20.70. Today a station-to-station call between the same points in the daytime costs $9. After 8:30 p.m. the cost of such a call is still further reduced to $5.50. At the same time the volume of traffic has been increasing. Even as late as 1920, five years after the opening of the service, the daily average was only twenty-one messages. Today the five transcontinental routes carry an average of about 250 messages a day to and from the same Pacific Coast points. In addition, nearly 400 messages per day cross the continent to and from points on the Coast not reached in 1920. Circuits for radio broadcasting networks and many private wire telegraph contracts are likewise provided by these lines.

With the telephone frontiers extended to coincide with those of the continental United States, the "appropriate means" were at hand to connect any Bell telephone with any other Bell telephone, in any part of the country. By 1927 the System had made sufficient progress toward it to enable Mr. Walter S. Gifford, President of the A. T. and T. Company, to state in the course of an address: "Thus today, practically any one anywhere can talk by telephone with any one else, anywhere

else in the country. Moreover, any one in the United States can now converse by telephone with any one in Great Britain, Canada, Cuba and the principal cities of Mexico. This is real progress in extent and facility of communication, but we realize we are still far from our ultimate goal."

Radio Telephony

The development of the vacuum tube as a basic element in telephone repeater systems made transcontinental telephony practicable. At the same time that experiments in its application to wire telephony were being conducted, the telephone engineers of the Bell System were also experimenting with its possibilities as an instrumentality for transmitting the human voice by wireless or radio telephony. Where physical facilities could not be provided, they hoped to send and receive speech through the ether.

The radio experiments had paralleled those bearing on the development of long distance telephone lines. A few months after the transcontinental line was opened, the first successful experiments in transmitting the human voice across oceans by "wireless" were conducted. From the United States Government radio tower at Arlington, Va., the telephone company engineers broadcast speech which was heard as far away as the Panama Canal Zone, Hawaii, and by A. T. and T. Company engineers stationed in the Eiffel Tower, in Paris.

During the third decade of the century, the war-born impetus to industry in general brought a demand for telephone service far beyond anything previously experienced. To carry out its service obligation to the public, the System drew upon its full resources in the fields of engineering, construction and operation. New developments were brought forward to meet the changed conditions. Long toll cables were designed, together with their associated repeater stations and other apparatus. Dial systems were introduced where service conditions required them. Circuits and equipment making possible

network broadcasting became part of the System's steadily increasing facilities. Great advances were made in the technique of operation, which resulted in faster, better service. The original transcontinental line was supplemented by four additional routes between the East and the Pacific Coast. The toll cable joining Boston, New York, Philadelphia and Washington spread into a network covering the northeastern states and extending west to Omaha, south-west into Texas, and south into the Carolinas.

Extension of the physical facilities to the borders during these years provided telephone contact with neighboring nations. Additional lines were built northward to Canada. In 1921 three deep-sea telephone cables connecting Key West with Havana were placed in service. Six years later service was opened between the United States and Mexico.

Overseas Service

And eight years ago, in 1927, came another triumph of research and engineering, when the Bell System opened its telephone "gateway to the world," through the inauguration of radio-telephone service between New York City and London, marking the beginning of an overseas communication service that now embraces sixty foreign countries and island groups.

This accomplishment in utilizing radio as an adjunct of wire telephony is a fascinating chapter in the story of the search for "other appropriate means." It is the story of outstanding achievement in the development of many types of vacuum tubes, with a water-cooled 10-kilowatt tube to mark the progress of the evolution. It is the story of patient study of antenna systems—such as the antenna, three miles long, that is used for long-wave reception at Houlton, Maine; the curtain type suspended between lofty steel towers used initially for short-wave transmission, at Lawrenceville, N. J.; the more economical "rhombic" type later used for both sending and receiving stations and now employed in the services to Europe,

South and Central America and the Orient. It is the story of improvements in transmitters and receivers, of protective devices to insure the safety of attendants operating apparatus requiring the use of great quantities of electrical energy, of anticipating needs and preparing for them and of solving new problems as they arose in the operation of a new and spectacular branch of the telephone art.

One milestone after another was passed by the Bell System in the study of radio and its application to telephone service. The first—the successful tests carried on at Arlington—has been mentioned. Another in 1916, was the provision of "means" whereby the Secretary of the Navy, at his desk in Washington, conversed by telephone with the commanding officer of the battleship New Hampshire, at sea off Cape Hatteras. A third was the establishment of the first commercial radio-telephone service, which in July of 1920 linked Catalina Island, thirty miles from California, with Bell System telephones. Another was a ship-to-shore conversation between President H. B. Thayer at his Connecticut home and Captain Rind of the S.S. America some 400 miles from New York, in 1922.

Station WEAF, broadcasting from towers on the roof of the Bell Telephone Laboratories building at 463 West Street, New York City, was an experiment of the American Telephone and Telegraph Company on broad lines to aid in determining the Bell System's relationship with the new industry, radio broadcasting. Completed in 1922, it operated for four years before the Company sold it to the National Broadcasting Company. During that period the technical features of radio transmission were studied while the station was in daily operation and much valuable information was learned which was applicable to radio telephony.

In co-operation with the British Post Office, which operates the telephone systems of England, Scotland, Wales and Northern Ireland, the Bell System radio engineers made preliminary

arrangements looking toward the ultimate establishment of commercial radio telephone service between this country and Great Britain. By 1923 the tests had reached a point at which it was possible to carry out the first public demonstration of the service. This consisted of one-way transmission only, from New York to London. By 1926 the Post Office had completed the installation of its transmitter, and a public demonstration took place with both sides sending and receiving. The following year transoceanic telephone service was inaugurated on a commercial basis.

* * *

So much has been written concerning the extension of the territory reached by the overseas telephone service that it is unnecessary here to detail the successive steps. By the middle of 1928 a second circuit connecting the New York and London terminals, but operating on short wave lengths, was placed in service. The following year two more short wave circuits were added to the one already operating from the Lawrenceville, N. J., transmitter and the Netcong, N. J., receiver.

During 1930 the first circuit to South America commenced operating from the Lawrenceville-Netcong stations. In the same year service was opened with Australia by interconnecting the New York-London circuits with that linking London and Sidney. Similarly, in the following year Java was reached over the Amsterdam-Bandoeng channel. Early in 1931 a transmitting station for ship-to-shore service commenced operating at Ocean Gate, N. J., and replaced the experimental station at Deal. The receiving station, at Forked River, N. J., had been in service for some months. Toward the end of the same year—1931—a second South American channel from the New Jersey stations brought Brazil within reach of Bell System telephones. A few days later service was extended to Bermuda through additional equipment provided at the same stations.

New stations near San Francisco, constructed for trans-

Pacific service, brought Hawaii within voice range of the United States just in time to transmit Christmas greetings on December 23, 1931. A little less than a year later other stations were established near Miami, Fla., operating on short wave lengths and affording telephone access to countries in Central and South America, as well as the Bahama Islands.

Through the seventeen separate radio channels now operating from A. T. and T. Company stations, as well as land wires and cables to neighboring nations, overseas service today connects any Bell or Bell connected telephone with telephones in sixty countries and island groups. A summary of these countries follows:

North America—United States, Canada, Mexico.
Central America—Panama and Canal Zone, Nicaragua, Honduras, Guatemala, Costa Rica.
South America—Colombia, Venezuela, Brazil, Argentina, Uruguay, Chile, Peru.
Europe—All countries except, Russia, Albania, Greece, Bulgaria, Turkey, Estonia.
Asia Minor—Palestine, Syria.
Africa—Spanish Morocco, French Morocco, Algeria, Tunisia, Egypt, Union of South Africa.
Asia—India, Siam, French Indo-China, Japan.
Australia—Southern and Eastern portions.
Islands and island groups—British Isles, Bahamas, Bermuda, Cuba, Canary Islands, Sicily, Balearic Isles, Sumatra, Java, Celebes, Philippines, Hawaiian Islands.

Ship-to-shore telephone service is operating on a commercial basis with twenty liners regularly crossing the Atlantic or running between New York and Bermuda and the Bahamas. While several of these vessels have been on round-the-world cruises, service has been successfully maintained with them at practically all points during their voyages. In some cases,

contact was established through the Pacific Coast stations when the ships were out of range of those in New Jersey.

Progress in Europe

Necessarily the progress of extending the scope of overseas service is affected by the extent of telephone development in the territory to be connected. While it is true that telephone service in this country is in advance of the service abroad, particularly with respect to long distance service, nevertheless much progress has been made by the European nations, especially during the last fifteen years. The map of Europe indicates the difficulties encountered in establishing a comprehensive long distance service throughout the continent. Thirty-three nations are involved, each with its own language, currency, customs barriers; each with a telephone system of its own, made up of equipment in large part differing from that of any other system with which it was to be connected.

In an effort to overcome these and other difficulties, the leading telephone administrations in Europe eleven years ago formed the International Advisory Committee on Telephony—more commonly known as the C. C. I. F. The remarkable achievements of this body are described in an article in the October, 1934, issue of the Bell Telephone Quarterly. A direct reflection of its work is found in the rapid spread of overseas telephone service throughout Europe.

Another factor aiding the progress of international telephony has been the development of short wave radio circuits in all parts of the world. As might be expected, the possibilities of short wave transmission made instant appeal to European nations with far-flung colonial possessions. Great Britain, France and the Netherlands, with Germany, have established short wave telephone channels to all parts of the world. In most cases these circuits can be interconnected with the channels serving the United States through the Bell System stations.

* * * *

At the disposal of America's telephone users there is today an instrumentality for personal communication with the far corners of the earth.

The principle was discovered June 2, 1875. Its first application to human needs was when two telephone instruments could be connected by wire and speech interchanged between the two. This was the earliest form of electric telephone communication. The first proof of limitless possibilities came in May, 1877, with the trial in Boston of the first crude switching system, for switching meant intercommunication, or the application of the principle to the needs of the many instead of the few. At the first commercial switchboard, installed in New Haven in 1878, eight lines centered and twenty-one subscribers were served. Even this primitive switching mechanism made possible only twenty-eight different connections among the eight lines.

In that is seen the telephone's destiny: not merely to connect but to interconnect, to grow in usefulness until none shall be left without the "appropriate means" for speaking one with another over the barriers of distance. In fulfillment of this destiny, switchboards grew to serve first hundreds and then thousands. This was interconnection, but only local. A company was formed to interconnect these localities and "Long Distance" was born, at first to extend the range of speech from city to city, but gradually from state to state until the nation was spanned by wire highways and there was no part of the nation which could not be interconnected with any other part. But the telephone's destiny was still unfulfilled, and even before national interconnection was a reality an international service was envisioned, was sought, was found.

As we contemplate today's agency of speech transmission, and read again the ambitions of the founders of Long Distance, the association of "other appropriate means" with world-wide telephony is inevitable. But there is far more than scope of service alone as a measure of progress. There is also

the endeavor to transmit speech ever more clearly, and ever more economically. These endeavors, as well as the effort to widen the range of speech, are all activities based on the same ideal. It is enough to contrast the service of any year with the year preceding, whether involving one mile of wire or a thousand, to realize the complete significance of "other appropriate means" as this historic phrase has been understood by the American Telephone and Telegraph Company, by the Associated Companies, by the Bell Telephone Laboratories, by the Western Electric Company, in fact, by each constituent part of the Bell System.

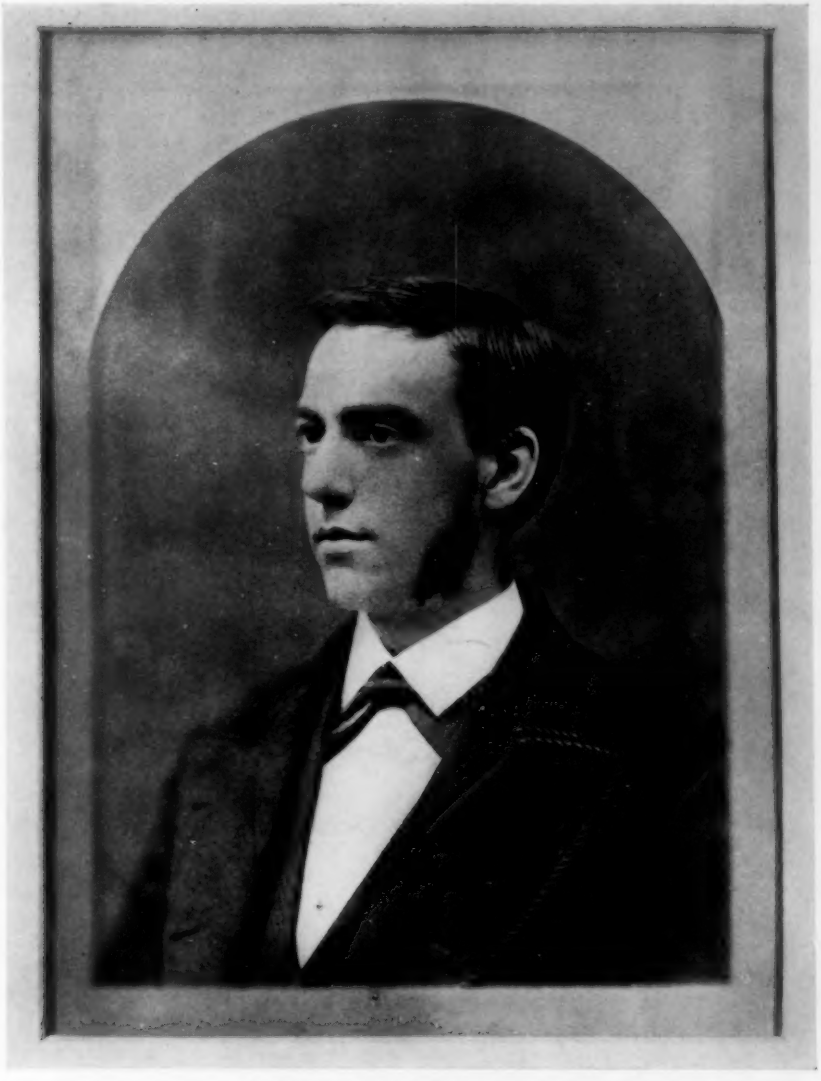
K. T. ROOD

Thomas A. Watson's Contributions to Telephony

THE last of the original group of pioneers in the telephone art passed away when Thomas Augustus Watson died on December 13, 1934, in his eighty-first year. When we speak of the present day marvels of telephonic communication, no longer can we say that the man who made the first telephone is still living. Mr. Watson's fame has been based largely on the facts that his hands made the first telephone and that his ears heard the first complete sentence transmitted electrically over a wire. To the average person, these two events overshadow somewhat his own important contributions to the development of the telephone when, after Bell's departure to England in 1877, he was the sole technician in the group who struggled to put the telephone business on its feet. It is the purpose of this review to record briefly the contributions of Watson to the telephone industry.

As a mechanic in the shop of Charles Williams, Jr., at 109 Court Street, Boston, Mr. Watson was assigned, during the winter of 1874, to make electrical apparatus for Alexander Graham Bell, a teacher of deaf persons and a Professor of Vocal Physiology at Boston University, who was experimenting in electrical devices to send more than one telegraph message over a single wire. Mr. Watson had previous experience in making electrical apparatus for others, and was considered the best of Williams' mechanics on this sort of work.

The instruments he made for Bell were transmitters and receivers for a harmonic telegraph system, whereby several telegraph messages could be sent over a single wire at the same time. As was to be expected, they were not exactly according to Bell's ideas. Bell's impetuosity led to his breaking the shop rules and making personal contact with the mechanic, so that



THOMAS AUGUSTUS WATSON.

This Photograph Was Taken in 1874, the Year in Which He Became Associated with Alexander Graham Bell.

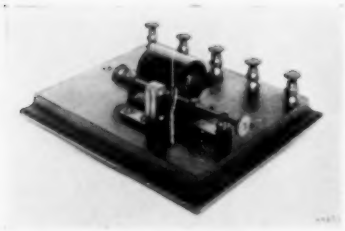


FIG. 1. HARMONIC TELEGRAPH INTERRUPTER, 1875.

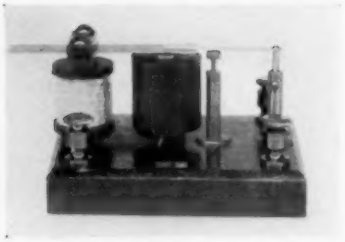


FIG. 2. HARMONIC TELEGRAPH RECEIVER WITH MORSE SOUNDER CONTACT, 1875.

FIG. 3. HARMONIC TELEGRAPH TRANSMITTER, 1875.

FIG. 4. HARMONIC TELEGRAPH TUNED REED RECEIVER, 1875.

FIG. 5. FIRST TELEPHONE TO TRANSMIT SPEECH SOUNDS, 1875.

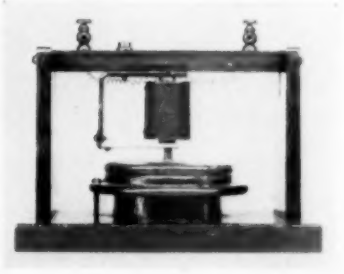


FIG. 6. ONE MODIFICATION OF THE FIRST TELEPHONE, 1875.

he might personally supervise the work. This led to more intimate relationships between Bell and Watson, who together worked over the problem that was in Bell's mind. It was an ideal arrangement, Bell with the ideas, and Watson with the mechanical ability to shape these ideas into concrete mechanisms. During this period, Watson, with his unusually alert mind, began acquiring a knowledge of electricity by home study (he left school at the age of 13) and thus laid a technical foundation for his later work.

Through the Winter of 1874 and Spring of 1875, Watson's work continued on the harmonic telegraph scheme of Bell's, and he assisted Bell with his experiments, as well as making his models. The attic of Williams' shop became an embryonic research and development laboratory. And Bell, with his typical research mind, while still experimenting with his harmonic telegraph, reasoned farther on the possibilities of the electric current and conceived the idea that if he could make an electric current vary in intensity, in the same way that sound waves in speech vary in density, he would be able to talk by electricity over a telegraph wire.

The incidents leading up to the first telephone are well known* and need not be enlarged in this article. Suffice it to say that the first "reduction to practice" of Bell's idea was made by Watson on June 3, 1875, when, following Bell's instructions, he constructed the first telephone through which speech sounds were transmitted by electricity.

Figures 1 and 2 show two models of a few of the instruments Watson made for Bell during his work on the harmonic telegraph system, and the final rather simple type of transmitter (Figure 3) and tuned reed receiver (Figure 4) used in the test of June 2, 1875, when the transmitter contact, accidentally screwed down too far, was plucked by Watson, producing an undulating current that Bell heard in the receiver

* "Exploring Life," Autobiography of T. A. Watson: "Birth and Babyhood of the Telephone"—T. A. Watson; "Beginnings of Telephony"—F. L. Rhodes.

at the other end of the line, confirming his conception of a varying uninterrupted current, which would enable one to talk over a telegraph line.

An examination of the construction of the first telephone (Figure 5) will show its apparent similarity to the harmonic telegraph transmitter: the electromagnets—coil and magnet—the same in both; a similar vibrating reed *except,* in the telephone, the end next to the magnet is hinged, and the other end is secured to the center of the goldbeater's skin diaphragm stretched over the hollow wooden cylinder forming the mouthpiece to receive the speech.

The tests with this first telephone were made in Williams' shop, over a line run from the attic down two flights to the third floor, near Watson's work bench. The receiver was the harmonic telegraph receiver shown in Figure 4. At this time, only very faint speech sounds were heard—not distinct nor articulate words. Today, however, connecting a model of this telephone through modern amplifiers, we can hear speech roar through loud speakers so as to be heard by thousands. Watson built several modifications of this instrument in an endeavor to make it talk plainer, an example of which is shown in Figure 6.

The "testing" laboratory was moved in January from the attic of Williams' Shop at 109 Court Street to a room in the attic of a boarding house at 5 Exeter Place; a second room, in the same attic, fronting on Exeter Place, was also rented by Bell, and used as his sleeping room. This was to insure more privacy of the tests than could be obtained at Williams' shop. A little later Watson moved from Salem into the remaining room in the attic at Exeter Place, which gave the two the entire attic for their experiments.

On March 10, 1876, Watson completed an improved telephone, to operate on the principle of variable resistance. A copper annunciator wire line was run from the laboratory room at the rear to Bell's bedroom in the attic at 5 Exeter Place.

On the evening of that date, Watson heard the first articulate sentence, "Mr. Watson, come here, I want you," transmitted over that line. The transmitter, and the receiver, which was still similar in design to the harmonic telegraph tuned reed, are shown in Figures 7 and 8 respectively.

During the next three months, Watson was busily engaged in making various modifications of the transmitter and receiver as instructed by Bell. Improvements were made in the first type of transmitter, as the liquid transmitter was not adapted for use outside the laboratory. Better transmission came over the improved instruments, and Bell decided to exhibit them at the Centennial Exposition in Philadelphia. These Centennial instruments, transmitter and receiver, are shown in Figures 9 and 10 respectively. Watson also made for this Exposition a group of exhibits including a harmonic telegraph transmitter and receiver and a liquid transmitter, to illustrate some of Bell's preliminary work on the telephone. The first public demonstrations of the telephone occurred during the summer of 1876 at this Exposition.

On September 1, 1876, Watson signed a contract with Mr. Gardiner C. Hubbard whereby he agreed to devote his time to the development of the harmonic telegraph and the speaking telephone, and as compensation was to receive one-tenth interest in all of Bell's patents, besides the same wages he had been receiving at Williams' Shop.

The first "outside" demonstration of a two-way telephone talk, between Boston and Cambridgeport on October 9, 1876, was made with two instruments, one at each end of the line, as shown in Figure 11. This telephone was used alternately as a transmitter and as a receiver. The illustration shows a large iron disc secured to the skin diaphragm, almost completely covering the vibrating area.

The next step was the use of a complete thin iron disc, eliminating the skin diaphragm entirely. Following this came the substitution of permanent magnets in place of the electro-

magnet, and the so-called "box" telephones came into existence. An experimental form of box telephone is shown in Figure 12; it was a single pole permanent magnet, with the coil of wire at one end, in front of which was the vibrating iron diaphragm secured to the inside of the box. Watson contributed a distinct improvement in the permanent magnet telephones when he built the magnet of four hardened steel horseshoe plates, bolted together with a small soft iron core to carry the coils of wire clamped to each of the pole pieces. This powerful horse-shoe magnet improved the talking so much that all telephones previously made with electromagnets or single pole permanent magnets were discarded in future tests.

Watson was at the distant end, at North Conway, New Hampshire, when on December 3, 1876, Bell at Boston conducted tests over a railroad wire and the human voice was carried between points separated by more than one hundred miles. In the Spring, Bell gave numerous lecture demonstrations in various cities in the East, with Watson assisting at the other end of the line. On April 4, 1877, the first commercial telephone line was run from Williams' shop to his home in Somerville, three miles distant.

The box telephone took the form shown in Figure 13. It was used as a transmitter and as a receiver. Production at Williams' shop was speeded, and minor changes were made in the design of every lot of boxes manufactured.

At first the only method of signaling between the two telephones was by means of tapping the iron diaphragm with a pencil through the mouthpiece. This produced only a faint sound in the called telephone, and quickly resulted in damaging the diaphragm. Watson soon remedied this difficulty by designing a hammer or clapper, arranged so that when raised by pushing a button from the front, it forcibly struck the diaphragm on the base of the front of the box, instead of on the vibrating portion. This produced a loud sound easily heard at the distant called telephone. It was the first calling

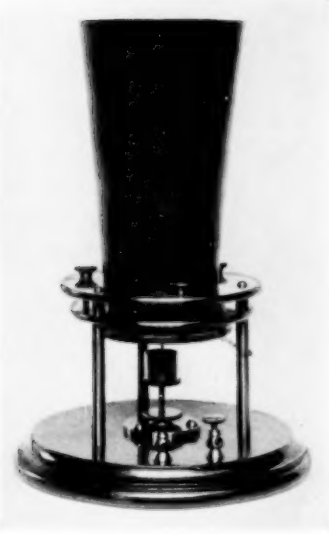


FIG. 7. LIQUID TRANSMITTER OF MARCH 10, 1876.

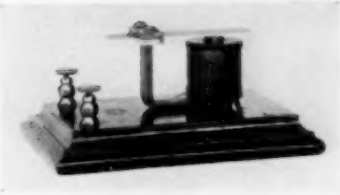


FIG. 8. TUNED REED RECEIVER OF MARCH 10, 1876.

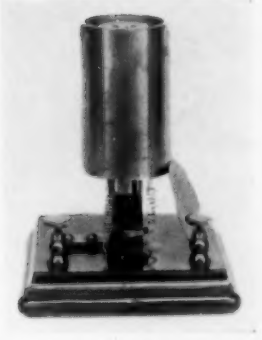


FIG. 10. IRON BOX RECEIVER EXHIBITED AT PHILADELPHIA CENTENNIAL, 1876.

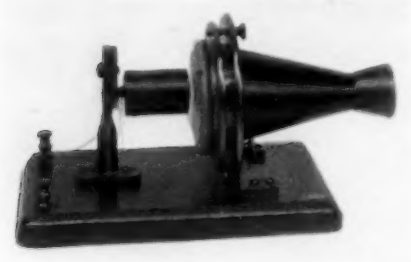


FIG. 9. TRANSMITTER EXHIBITED AT PHILADELPHIA CENTENNIAL, 1876.

FIG. 11. TRANSMITTER AND RECEIVER USED IN BOSTON — CAMBRIDGEPORT TEST, OCTOBER 9, 1876.

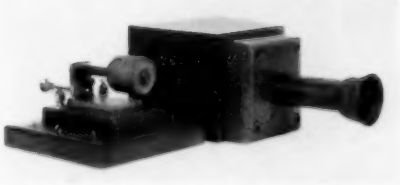


FIG. 12. EXPERIMENTAL BOX TELEPHONE WITH SINGLE POLE PERMANENT MAGNET, 1876.

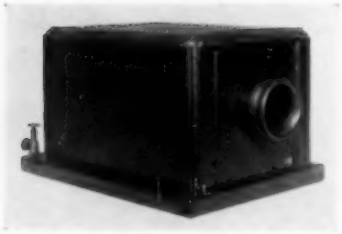


FIG. 13. FIRST COMMERCIAL BOX TELEPHONE, 1877.

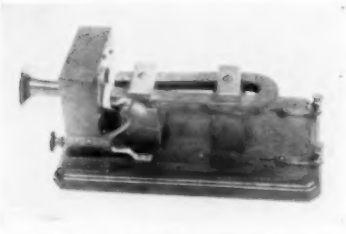


FIG. 14. FIRST CALLING DEVICE, "WATSON'S THUMPER," 1877.

FIG. 15. CALLING DEVICE, "WATSON'S BUZZER," 1877.

FIG. 16. WOODEN HAND TELEPHONES. FIRST FORM 1877.

FIG. 17. FOURTH FORM 1877.

FIG. 20. FIRST TYPE OF WALL BOX TELEPHONE, 1877.

FIG. 18. RUBBER HAND TELEPHONES. FIRST FORM 1877.

FIG. 19. FIFTH FORM 1877.

FIG. 21. SMALL WALL BOX TELEPHONE FOR SHORT LINES, 1877.

apparatus ever designed and used for the telephone, and was popularly known as "Watson's Thumper," shown in Figure 14. A large quantity of box telephones equipped with "thumpers" were manufactured and sold, although it was recognized that the instruments were somewhat clumsy and the signaling far from satisfactory.

This led to a device designed by Watson employing the harmonic telegraph idea of a vibrating reed, which became known as Watson's "Buzzer," shown in Figure 15. This consisted of snapping a vibrating reed between two contacts connected through the primary of an induction coil, with the secondary connected to the line. By pushing a plunger with a coil spring return to complete the line circuit, it was possible to control the impulses sent out on the line: to make interrupted calls or signals for party line service, when more than two telephones were on a line. This buzzer was also used as a calling device on the first commercial switchboard, designed by George A. Coy and installed in New Haven January 28, 1878. It was facetiously called "Coy's Chicken."

In the meantime, a separate series of experiments was being conducted in the Spring of 1877 by Bell, which resulted in constructing a light portable telephone, convenient to hold to the ear, known as a hand telephone. Its first form, appearing in May, was known as the "Butter Stamp" receiver, shown in Figure 16. The fourth form of wooden hand telephone, Figure 17, came out in June. Modifications of this hand telephone continued through the year. In the Fall of 1877, Watson superseded the wooden container with a rubber shell as shown in Figure 18, and by December the fifth form of rubber shell, with a screw cap, was developed and placed in service. This receiver was generally known as the Hard Rubber Hand Telephone (Figure 19), and with minor changes in design was in use for many years until the introduction of the double pole receiver. All these hand telephones had a straight magnet, either single or compound, and while they were used to

some extent for both talking and listening, the preferred combination was the box telephone for the transmitter, as it had the more powerful horse shoe magnet, and the hand telephone for the receiver.

The box telephones were rather bulky and costly to manufacture, and Watson re-designed them at a saving in cost of about one half. The diaphragm and coils were placed at right angles to the magnets, which greatly reduced the size and permitted the box to be mounted against the wall, instead of on a shelf. The first wall box telephone was brought out in August of 1877, and is shown in Figure 20. These, like the hand telephones, were continually modified during that year. One of the small forms, used for very short line service, such as in hotels, is shown in Figure 21. It will be noted that the mouthpiece is much smaller than in the picture of the first commercial box telephone. This was an improvement made by Watson on the large box telephones, and resulted in a greater concentration of the sound waves on the diaphragm and hence improved transmission.

In May, 1877, Bell and his associates, Gardiner C. Hubbard, Thomas Saunders, and Watson entered into an agreement with Charles Williams, Jr., to become the manufacturer of the Bell instruments for public use. During this month there appeared the first circular, over the names of Hubbard and Watson, advertising the telephone. It is noteworthy that this very first circular stated that the telephones were to be leased to subscribers, and not sold outright. Up to this time, Watson had made practically all the telephones by hand, but now this was no longer possible, and he gave orders on Williams to make twenty-five box telephones and fifty of the hand form. His time was then occupied in supervising their construction and, as mentioned above, in improving them and reducing their cost. He even went with Mr. Hubbard to Altoona, Pennsylvania, and installed two sets of telephones on a line belonging to the Pennsylvania Railroad.

On July 11, 1877, Bell married Miss Mabel Hubbard, daughter of Gardiner Hubbard, and in August of that year set sail for England, where he spent several months trying to start the telephone business in England. About this time Watson dismantled the laboratory at 5 Exeter Place, as it was too small for the increasing amount of research work required, and returned to Williiams' shop for his further experimenting on the telephone and the associated apparatus. Watson was now the only person who was responsible for improvements and the design of auxiliary apparatus, to meet the demands of the rapidly growing industry; he was inventor, designer, and superintendent of manufacture. In April, 1877, only six telephones were in practical use, with little or nothing in the line of auxiliary apparatus. On November 1, 1877, three thousand telephones were leased, with the apparatus needed for their practical use.

In the latter part of 1877, Watson designed a combined fire alarm and telephone system. The fire station was automatically signaled when the door to the telephone box was opened for the use of the wall box telephone inside. A picture of this fire alarm box is shown in Figure 22.

The buzzer calling device was not entirely satisfactory on account of its screechy sound, and Watson decided that a bell that would ring without a battery was the answer. He designed a magneto generator for the alternating current, based on a magneto electric shocking machine he had previously noticed in his reading at the Public Library, and a polarized bell was created, with his ingenuity, from a polarized telegraph relay. These were placed in service early in 1878. They are shown in Figures 23 and 24 respectively. An early form of complete subscriber set first using these units is shown in Figure 25, and was known as "Williams' Coffin," from the peculiar shape of the box. This illustration shows two hand telephones, one for use as transmitter and the other as a receiver. A few subscriber sets were equipped with only one hand telephone,

but subscribers would sometimes reverse the single telephone, and try to talk with the ear and listen with the mouth! This set also shows the small switch used to cut out the coils of the bell while talking, and switching them in after the conversation was completed. Many subscribers forgot to operate the switch, so a hook for holding one of the receivers was located near the switch handle so the receiver could not be hung up unless the switch was restored.

The final combination was a wall box telephone with its powerful magnet used for the transmitter, and the hand telephone for the transmitter, shown in Figure 26. To overcome the difficulty with the hand operating switch, Watson designed an automatic spring switch which was operated by the weight of the receiver. An agent of the company in New York City, Mr. H. L. Roosevelt, also designed a similar switch at about the same time, and in the final arbitration proceedings he was awarded priority and the patent was taken out in his name. This subscriber set is equipped with this form of switch.

The rapid growth of the use of telephones from single lines into two or more stations led to the demand for switching facilities between stations on different lines. The first telephone exchange switchboard was made experimentally as early as May, 1877, and operated for a short time in the office of E. T. Holmes in Boston, Mass., but it was not until January 28, 1878, that the first commercial telephone exchange was placed in operation, at New Haven, Connecticut. The agents licensed in the various cities had experienced a growing demand for telephones throughout the Fall of 1877, so that a few manufacturers of electrical apparatus in strategic geographical locations were licensed to make telephone apparatus to relieve the pressure on Williams' shop in Boston.

In February, 1878, Watson made an extended trip through the West to induce the agents to establish telephone exchanges, and incidentally to get first hand information on the field conditions prevailing in the operation of the telephone in service.

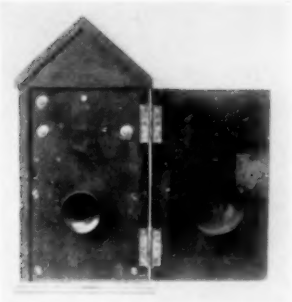


FIG. 22. FIRE ALARM TELEPHONE, 1877.

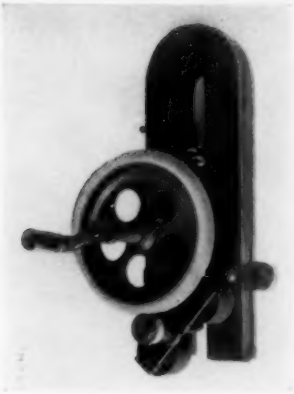


FIG. 23. HAND GENERATOR, 1878.

FIG. 24. POLARIZED RINGER, 1878.

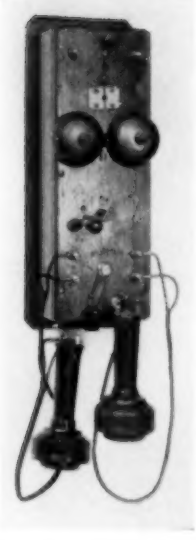


FIG. 25. EARLY FORM OF WALL TELEPHONE, "WILLIAMS' COFFIN," 1878.

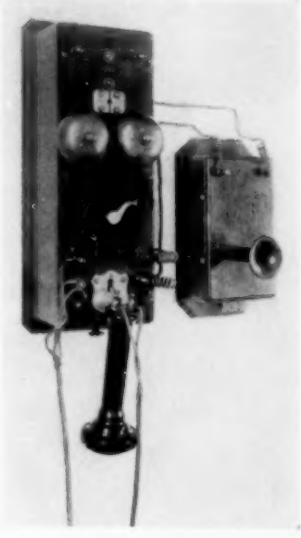


FIG. 26. "WILLIAMS' COFFIN" AND SEPARATE WALL BOX TRANSMITTER, 1878.

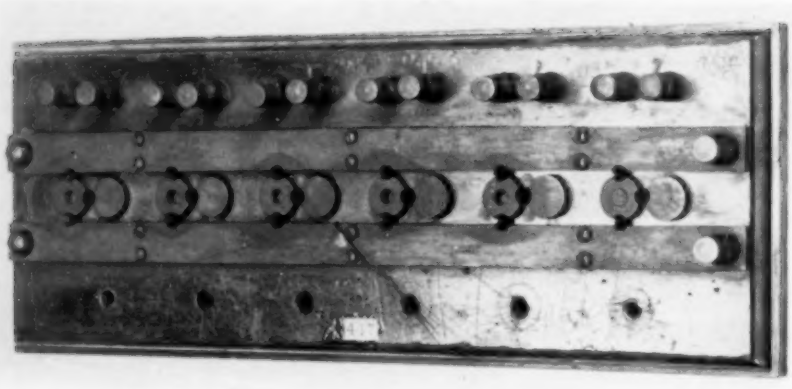


FIG. 27. WATSON'S PEG TELEPHONE SWITCHBOARD, 1878.

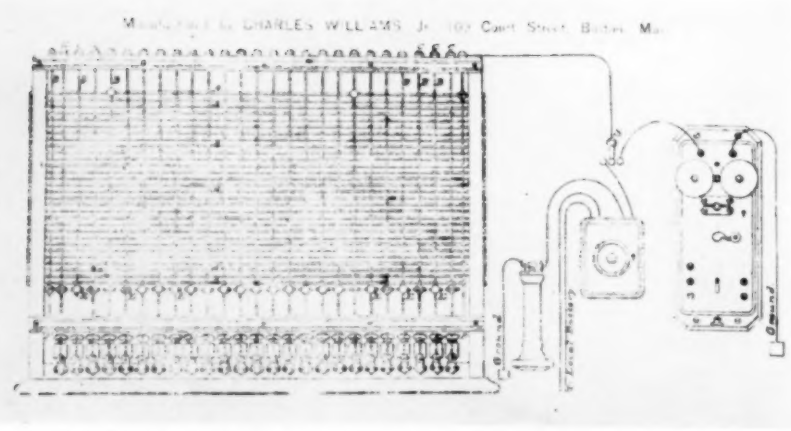


FIG. 28. "WATSON'S SLIDE SWITCH" TELEPHONE SWITCHBOARD, 1880.

This trip impressed Watson with the tremendous possibilities ahead—as well as the need for further development of the telephone and auxiliary apparatus. On his return he first made some improvements in his magneto ringer, and then devised an individual call bell, whereby only one party on a line containing several telephones would be called. His design was somewhat complicated for practical use. The ultimate solution was to put fewer stations on a line.

He next devoted his time to designing a switchboard. Watson had persuaded several of his agents to establish telephone exchanges, and consequently they looked to him to provide the equipment. One of the earliest switchboards designed by Watson is shown in Figure 27. This is the board that was installed in Philadelphia. Another was sent to Detroit, and others elsewhere. This resembled closely a telegraph peg switchboard, the several lines being connected together by brass pegs at the ends of cords, inserted between the metal discs.

Agents in cities he had not visited in February were insistent on Watson's personally visiting them to bring them up to date in the rapidly expanding business. Accordingly, on May 21st, 1878, he started on his second trip West. On the way he stopped off at Washington to interview Mr. Theodore N. Vail, then Superintendent of the United States Railway Mail Service, whom Mr. Hubbard desired to engage in the telephone business, so Mr. Watson could be relieved of all his many duties except strictly engineering work. On Watson's advice, Mr. Hubbard engaged Mr. Vail as General Manager. He also recommended to Mr. Hubbard that some agreement be made with Mr. Berliner for the use of his new loose contact microphone.

During the Spring and Summer of 1878, when not on trips, Watson spent most of his time endeavoring to develop a transmitter that would talk as well as the carbon telephone that Edison, whose inventions were being used by the competing

Western Union interests, had developed. This continued until October, when Francis Blake submitted for test a design of hard carbon button transmitter. Watson tested this in the shop and found it talked as well as Edison's, and he recommended the purchase of Blake's rights. Watson dropped his experiments on non-carbon transmitters, devoted his energies to the production of Blake transmitters, and within two months there were over a thousand in use, working even better than the Edison transmitter.

During this Summer the agents began to work out some of the simpler problems connected with their rapidly growing business, and the licensed manufacturers also began making improvements in their apparatus, as well as constructing switchboards for central offices. More and more of Watson's time was devoted to the problems presented by the agents in the field, and the routine work in the shop was turned over to men who were hired to assist him in Boston. Emile Berliner came in September, 1878, and was followed later by Anders, Henck, Jacques, Gilliland, Lockwood and many others, all of whom made contributions to the development of the communication art. Each trip to the agents in the field resulted in some new problems to be worked out by Watson and his assistants.

When the Bell Company began suit early in 1879 against the Western Union interests for infringements of Bell's patents, Watson, in addition to his regular work, spent considerable time in testifying, and in making models of the original telephones. This occurred at a most inopportune time, because of the continuously increasing number of situations in the field requiring his attention for the modification of existing apparatus and the development of new methods for switching and signaling, and of attempts to overcome line troubles. During this year and the following, in his capacities as Superintendent and Chief Engineer, he not only was the main contact with the telephone company's agents in the field, but he also supervised

the development work at the factory and contributed some important improvements on his own initiative.

Examples of the wide range of the technical consulting service rendered by Watson during this period are the two following letters:

From Theodore N. Vail, General Manager, at Boston, to Mr. H. W. Pope, in New York City, under date of June 26, 1879:

"Before putting in any exchanges or starting in or even planning for a central office system, I think it would be well for you to consult thoroughly with Mr. Watson, and examine minutely into our standard system for central office connections. What we want to do in every case is to adopt the best system, and that we think we have. Then if there is anything better we should of course want to adopt that.

"Please let me hear from you in regard to this."

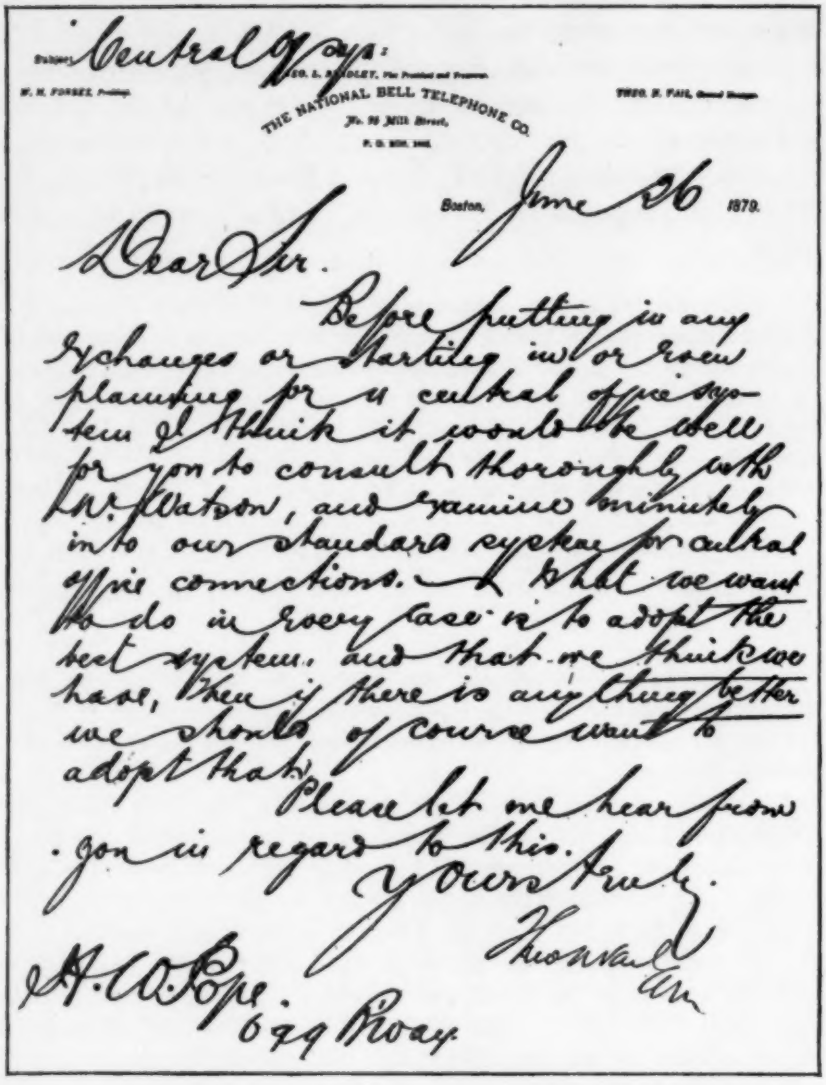
From Samuel Hubbard, General Agent for Pacific Coast, at San Francisco, California, to Mr. Watson, in Boston, under date of Sept. 10, 1879:

"My agents at Oakland are very anxious to have telephonic communication with this City, and if arrangements can be made to build the line a large business can be made between the two places and intermediate stations.

"Oakland is 5 miles by water and 100 miles by land from this place. The Western Union Tel. Co. laid a cable across the bay, but it was abandoned on account of the expense of keeping in repair, too many vessels in the way. By building the line around the bay, we take in San Mateo, Redwood, Menlo Park, San Jose, San Leandro, Alemada and Oakland. At each of these places we can establish branch offices. The line can be built on the poles of the Bay Coast Telephone Company of which I am the agent. What I want to find out is, is a line of this length practicable, with all of these connections. What calls could we use, etc. etc.

"Last fall the opposition * built a telephone line of 70 miles in length for the North Bloomfield Mining Co. They are using 30 sets of telephones, Edison Carbon. They have a relay which breaks the circuit, closing a local circuit on the back stroke, which rings a vibrating bell.

* The American Speaking Telephone Company, the subsidiary of the Western Union Telegraph Company.



Subject: Central Offices

W. H. FORBES, Treasurer. GEO. L. SHEPLEY, Vice President and Treasurer. THEO. N. VAIL, General Manager.

THE NATIONAL BELL TELEPHONE CO.

No. 95 Milk Street,

P. O. BOX 986.

Boston, June 26 1879.

Dear Sir.

Before putting in any changes or starting in or new planning for a central office system I think it would be well for you to consult thoroughly with T. D. Watson, and examine minutely into our standard system for central office connections. What we want to do in every case is to adopt the best system, and that we think we have, then if there is anything better we should of course want to adopt that.

Please let me hear from you in regard to this.

Yours truly.

Theo Vail

J. H. A. Pope.
629 Broadway

"What We Want to Do . . . Is to Adopt the Best System."

A letter from Theodore N. Vail, in 1879, which makes reference to Mr. Watson's central office system.

The Co. are not very well satisfied with the telephones or bells (the bells they purchased at $24 each). And they have told me when their contract is out they would like to receive a bid from our Company to furnish them with telephones. I should be pleased to receive your advice on the subject.

" In the Snow Sheds of the Central Pacific R. R. Co. a distance of 40 miles there are 36 Am. Dist. Tel. Boxes on the line which are used for Watchman Signals. Telephones are used on this line at 6 stations, but they do not give very good satisfaction. They use the induction call for a signal which can only be heard at a very short distance from the instrument.

" What they want is something that will give a regular and different signal for each box, or any improvement over the present system.

" I have told the Asst. Chief Eng. who has charge of the track that I would write to you on the subject. He says they may extend their line 24 miles on one end and 35 miles on the other. The C.P.R.R.Co. are using some 75 of our telephones. I am anxious to give them any advantage.

" I am quite disgusted with our tap bell, they do not give satisfaction. I am sorry I ever put them in. The magneto bells are much the best in my opinion."

Among Mr. Watson's many improvements in apparatus may be mentioned refinements in the polarized bell and in other methods of signaling through bells on party lines, the adaptation of telephones for use in divers' helmets, the addition of a spring contact in subscriber set door hinges for more reliable connections, the first desk stand, and the use of cord pulleys or weights to prevent switchboard cords from becoming tangled. Illustrations of his contributions to operating methods include an intercommunicating system for groups of telephones in the same office building, switchboard and exchange system circuits for use in Williams' line of switchboards, and a switchboard which came to be known as " Watson's Slide Switch "—shown in Figure 28. This drawing is taken from Williams' catalog published in 1880, which also gives a complete description of its operation.*

* All of the illustrations except Figure 28 are of models or original instruments in the Bell System Historical Museum.

Induction, or crosstalk, on the telephone lines, due to electrical disturbances from neighboring telephone and telegraph lines, and also electric power lines, was a problem that baffled the early telephone workers. A step in the solution of this difficulty was the use of straight metallic circuits through the area of induced currents. A very important development of Watson's affecting the outside telephone plant was the use of the repeating coil, whereby a metallic circuit could be connected to ground circuits at one or both ends without producing noise on the metallic circuit itself. These repeating coils are an essential feature of every telephone system today, among their uses being the creation of phantom circuits and in the numerous places where it is necessary to connect unbalanced circuits to those which are balanced with respect to ground.

While a large number of Watson's important contributions to the telephone art were protected by patents, many of his ideas were adopted in the ordinary course of routine development and construction in Williams' Shop, and were not the subject of patent application. There were also quite a number of his ideas on transmitters and receivers that, while patented, were not introduced generally in the telephone business.

Early in 1881 Mr. Watson, who for seven years had carried the brunt of putting Bell's telephone on its feet, from an operating standpoint, felt the need for a well earned rest, and resigned from the telephone business. He, more than any other individual, was responsible for the growth of the telephone in its infancy, and left to others following him a husky child, which even today is continuing to grow in usefulness and service to mankind.

W. C. F. FARNELL

The Changing Years as Seen from the Switchboard

Editor's Note:

The interviews appearing under the above title in current employee magazines of the Bell System are reprinted here as affording an interesting supplement to "Opportunities for Women in the Bell System" which was published in the BELL TELEPHONE QUARTERLY *for January, 1932. The first two appeared in the* QUARTERLY *for January, 1935.*

III. WHY WOMEN ENTERED THE TELEPHONE SERVICE

"Alexander Graham Bell opened the door of opportunity for women," began Miss Laura Smith.

We started scribbling furiously. Here, we made a mental resolution, was the sentence with which we would begin the third of the interviews on the part which women have played in the development of America's nation-wide telephone service. We were about half way through the sentence when Miss Smith interrupted us.

"You needn't take that down," she remarked.

"Why not?" we protested, for we thought we knew a good sentence when we saw one.

"Because you don't have to—you already have it, right here in this binder," Miss Smith countered. "These aren't my words—though I wish they were, for they exactly sum up the situation that existed in the pioneer telephone days. No, they aren't my words—they are the words of one of those first telephone operators, and one who is very typical of all of them—Margaret Mackin (Hyatt) who began work at the switchboard in Chicago in 1883.

"Really, you know, you aren't interviewing *me*—you are personally interviewing these young women of the late Eighties and early Nineties, by proxy. You are seeing them through

my eyes. When they speak, they speak through my lips, but the words are their own—you'll find them all here in their answers to our questionnaire. If you could imagine a 'composite' telephone girl of that period, and imagine her sitting here in my office, talking to you—"

It would not have been so difficult to imagine such a young woman—one possessing the combined characteristics of all the operators who have recounted their experiences to Miss Smith and her colleagues. In their answers to the questionnaire, many of them have told at what ages they began work; some of them have described the dresses they wore on their first day at the switchboard. Practically all of them have told why telephone work attracted them; what kind of girls worked with them in the central offices; what other jobs they might have taken if they had not become telephone operators; what their duties were; what the operating rooms were like; what training, if any, was given them in order to help them do their work better or more conveniently; their hours of work, their wages—and an endless number of other things which enable one to visualize the pioneer telephone woman and to watch her as, step by step, she has developed into the telephone woman of today.

Characteristic Accents

As this composite operator speaks, there is in her voice a little of the twang of New England, a little of the soft and smoothly flowing speech of the Old South, a little of the forthright directness which one associates with the West of the frontier days, and even a subtle something which suggests the accents of the Canadian. Among the recollections of early telephone days are those of women who became operators in Boston, New York, Richmond, New Orleans, Chicago, Omaha, San Francisco and intermediate points, not to mention Montreal.

If one were to give this composite young woman an equally

composite name, it would rival the long lists of baptismal names boasted by members of the royal families of Europe. At the very least, one would have to call her Mary Katharine Frances Margaret Cecilia Viola Emma. As for her dress—

Painting a composite word picture of the dresses which these operators wore would be a complicated job for anybody, and for the writer it is all but impossible. In the interests of simplicity and accuracy, let us ask one of these women to describe herself as she looked in 1881 when, at the age of a little past fifteen, she went to work for the telephone company in Paterson, N. J.

"I wore," she confides, not without a touch of justifiable pride, "a garnet dress of cashmere, the waist of which was well boned (giving it a very delicate waist line), with small sleeves and a turnover white linen collar, fastened in front with a ribbon bow. The dress was about to my shoe tops—they were high button shoes—and my turban was made of the same material as my dress. You see, we had the ensemble idea even then. My hair was braided and pinned up around my head. No bobbed hair then—not for young ladies who were really grown up. I had worn short hair until I was ten, but now, at the advanced age of fifteen, I had put away childish things."

A Multitude of Answers

If we were to ask this composite young woman why it was that she entered the telephone service, we should receive a multitude of answers. The immediate causes which prompted these girls to become operators were almost as numerous and diverse in characteristics as were the girls themselves.

Here is one who went to work at the Nassau Central Office, New York City, in 1882. She says:

At the time, I was waiting for an appointment as a teacher in the public school, but the vacancies were few and the appointments were as a rule political preferments. There were but few other lines of work open to

young women and these were not appealing, as, for example, sales clerks in " dry goods stores " (department stores were not then in vogue).

The teaching profession lost a valuable recruit when this young woman, Miss Katherine Schmitt, became an operator. Her ability as a teacher was not, however, permanently lost. As will appear later in the present series, she became the first manager of the first operators' training school opened in the United States, or in the world, so far as can be ascertained.

Somewhat different in point of view, but hardly less typical of many other girls, was a young woman who began her telephone career in 1883, at St. Louis, Mo. In describing her entry into the service, she writes:

It was purely an accident that I sought employment with the telephone company instead of with some other concern. The only positions open to women on the outside were as salesladies or school teachers, and I did not want to be either. I had a friend who walked past my home on her way to work every morning, and I wanted to be like her—to go swinging down the street each morning to my job. She took me to the office one day, where I applied to the chief operator for a job and he (the chief operator was a man, you see) told me I could start work the next morning. Until the day I went to work for the telephone company, I had never seen or used a telephone.

Miss Smith is inclined to the belief that this young woman was a typical representative of many of her sister telephone women of that period. Some of them became operators because they had to have a job, but in the vast majority of cases, the necessity of obtaining work was not the controlling factor. Most of these girls went to work because the job was the first step toward the complete economic independence which they hoped some day to achieve. For many of them, looking for a job was in the nature of an adventure. And most of them have made it clear that they took the telephone job because there were, at the time, few other opportunities for the girl or woman without special training.

Some Other Lines of Work

"Perhaps," suggested Miss Smith, "this composite girl, who decided to become a telephone operator, had among her friends or acquaintances some girls who were working in factories or as sales clerks, or even as nurses or teachers. Perhaps she talked over her prospects with these friends. If she did, perhaps this was why she became a telephone operator. Look at these figures, most of which are gleaned from government reports covering that period."

We looked. The prospect, from the standpoint of a girl looking for a job at that time, was not exactly alluring. The average weekly wages of women workers in the Eighties, based on reports from the labor bureaus of eleven states, ran from a minimum in one state of $5.50 to a maximum in another of $6.68. The average for the eleven states was $5.80. As late as 1908, the starting wages for "cash girls" in shops averaged between three and four dollars a week; for saleswomen, the average starting wage was between three and six dollars a week. In the Eighties, these averages were, of course, considerably lower. With rewards of labor such as these, the wages offered in the telephone business compared favorably, to put it conservatively. In many parts of the country, the operators were paid nothing while learning but received pay as soon as they began actual work. Most telephone companies soon put into effect regular systems of wage increases, and the upward trend of wages was at least as rapid and in many cases far more rapid than in other kinds of employment.

"But the question of wages," Miss Smith pointed out, "was not, I think, the controlling factor. These young women felt that, from a number of standpoints, telephone work offered them the best available vocational opportunity. Points which many of them tell us they considered in selecting it were: steadiness of employment, opportunities for advancement, pleasant working conditions—such as shorter hours than in

factory work and less fatigue than would have resulted from work in stores. Many of the girls found a decided appeal in the fact that telephone work offered seclusion from direct contact with the public—you must remember that these young women were pioneers in finding a place for women in the business world, and some of them approached what lay before them with marked misgivings."

Whether or not these prospective telephone operators had discussed their plans with friends who were engaged in other lines of work, it is apparent from the data collected by Miss Smith that many of them had had heart-to-heart talks with telephone employees. Some of them had been taken by their operator friends into the central offices and were fascinated by the strange apparatus which they found there, and by the romance of this mysterious new art which enabled people to talk with each other by wire.

Influence of Telephone Friends

More than half the replies to Miss Smith's questionnaire state in one way or another that the choice of telephone work as a vocation was primarily due to the suggestion or influence of friends or relatives who were already working for the telephone company. The enthusiasm of these employees, who included both men and women, was so pronounced and they were so outspoken in telling their friends about it, that there was little difficulty, after the first few years, in obtaining operators. In fact, there were more applicants than there were positions, and many of the companies had to establish waiting lists of those who aspired to positions at the switchboard.

The First Women Operators

Many other replies to the questionnaire sent to these early operators make it clear that by the late Eighties the use of women at the telephone switchboard was a demonstrated success. All that the managers had to do, from this time on, was

to pick the best of the applicants. But it was not such easy sailing for the managers who first experimented with the heretical idea of employing women for work which men had been doing. It seems to be pretty well established that one of the first two women telephone operators was Miss Emma McNutt, of Boston, who has written that she began work "about the middle of September, 1878." Miss Mary B. Kennedy of New York was the other of the two pioneer telephone women.

"Don't you think that the managers who hired those two women must have had a good deal of courage?" we asked Miss Smith.

"I have always thought that those men were among the unsung heroes of the Bell System," was her answer. "They had no means of knowing whether those women would make good—or prove an unmitigated nuisance. There must have been among the superiors of these men some conservatives who trembled for the future of the telephone industry when the first girl operators took their places at the switchboard. There were still such conservatives, even after girls had been working as operators for some time. There was, for example, T. D. Lockwood, then an inspector for the telephone company in Boston, but later to become the Bell System's general patent attorney. He wrote in 1885 to Theodore N. Vail, then general manager of the system, a report which contained this not too optimistic view of the value of women operators:

> The operators are all females, which of course has its advantages and disadvantages, which here it is unnecessary to comment on, barely mentioning the fact that, notwithstanding the pronounced opinion of resident authorities that female operators are much superior to males, the fact remains, viz: That the office manager, unless an unusually well-balanced man, is liable to form preferences, in favor of some to the exclusion of others. The young ladies also appear fond of airing their voices and sometimes prolong conversation, to talk with subscribers, again losing time. On the other hand, they exceed males in civility and general attention to their tables.

"It is easy enough to smile, now, at Mr. Lockwood's misgivings in regard to the women operators," said Miss Smith, not without a suggestion of a smile on her own part. "Of course, the girls got over any inclination they may have had toward 'airing their voices.' The adoption of standard traffic practices and uniform operating phrases eventually took care of that, as it did of a number of other difficulties. But long before the standardization of operating practices and phraseology throughout the Bell System generally, individual managers had worked out operating practices of their own which went far toward enabling the operators to do their work more conveniently and efficiently, and thus to improve and speed up the service.

The Early Managers

"They must have been a remarkable lot, those early managers. The evidence is clear that they had exactly the qualifications which Mr. Lockwood demanded of them—they were 'unusually well balanced' and they preserved a praiseworthy balance in their attitude toward the employees who reported to them. They played no favorites, and yet managed to maintain a peculiarly close and sympathetic interest in all of the operators, their personal welfare, their work and their proggress. It seems to me that the foundation for the Bell System's present personnel policy was laid right then, by those pioneer managers of the telephone exchanges.

"Long before provision for sickness benefits had been adopted by the Bell System as a whole, or even thought of in many other industries, many of these men were seeing to it that no operator was neglected when overtaken by illness. Long before the well equipped dining rooms and recreation facilities of the present day had become accomplished facts, these managers were finding means of providing little comforts which made life in the central office more attractive and more wholesome.

"They were pioneers, these men who had charge of the early telephone offices—but they were pioneers in nothing so much as in the manner in which they won the respect and confidence of the women whom they supervised. You can find this fact clearly evident if you read the experiences of these first operators. Or, better still, why don't you talk with one of these women in person? There is Miss Katherine Schmitt, of whom I spoke a while ago. For your next article, why don't you ask her to tell you about the early switchboards, the development of operating practices and of training schools, and other points on which she has first hand information? Get her comments on what these other operators have written about their experiences. But before you do that, just ask her what she thinks of the managers of those first years of the telephone service—she ought to know, and I can guarantee that she will tell you just what she thinks."

A few days later, we talked with Miss Schmitt. Her dark eyes snapped as we read her the phrase from that report of long ago which pointed out the possibility that the central office managers were "liable to form preferences."

"Well—did they?" we asked.

"Never, so far as I could see," Miss Schmitt replied, without a second's hesitation. "I think I would have seen it if it had been there—I usually knew what was going on in the office. No, there were never any favorites—either in the early days or later on. They took a personal interest in us—all of us. That's what made the job run smoothly. It did more than that—it was, I think, the basis for one of our Bell System traditions.

"You know, we hear a lot about the 'Spirit of Service' of the telephone operator. She has it, all right, and she had it in those early days. But I think the loyalty of the operator was reflected, as a mirror reflects light. It really came from the men who managed those central offices. You just couldn't

be anything but loyal to your job and to the public when you were working for—or rather working *with*—men of that sort."

IV. Some Early Switchboards

One of the marvels of the telephone lies in what the telephone is—an almost universally accepted instrumentality of communication which, by means of a far-flung system of electrical facilities, provides a peculiarly intimate bond not only between individual and individual, but between nation and nation. But another marvel of the telephone lies in the fact that it has become what it is in so short a space of time. Less than sixty years ago the telephone art existed only as an unfulfilled hope. The man who heard the first sentence spoken over a telephone wire died but a few months ago. The history of the telephone covers a span no longer than the lives of many persons now living.

One cannot but be profoundly impressed by the significance of these facts if one is fortunate enough to talk with such a person as Miss Katherine Schmitt, of Brooklyn, who was one of the Bell System's early telephone operators. Keen of mind; with a memory which provides an almost photographic record of the events of those first telephone years; bright of eye, ready of speech—such a personality brings forcefully home to one the fact that, relatively speaking, these events happened "only yesterday."

Nor is Miss Schmitt an exceptional example of these pioneer telephone operators. One could find them in widely scattered cities and towns throughout America—women, who, despite advancing years, have kept a remarkably clear mental picture of their first days in the telephone service, and who retain an almost girlish enthusiasm and zest for the part in this service which it was theirs to play.

We had wanted to supplement the material collected by the Personnel Department of the American Telephone and Tele-

graph Company in answers to a questionnaire sent out to some two hundred of these pioneer telephone operators. We had wanted something a little more personal than the written word, albeit many of these trail-blazing operators had given a peculiarly intimate account of their life at the switchboard. We had asked Miss Schmitt if she would tell us something of the apparatus which served as a switchboard when she went to work in the Nassau Central Office, New York City, in 1882, and comment on the experiences of some of her sister operators in other cities. We had asked her particularly to picture for us the training methods, such as they were, that were used during her first years of service, and to comment on her experience with the subsequent development of methods of instruction—in which development, as will be seen in the next installment of this series, she played an important part.

Switchboards of Many Strange Sorts

"What about your switchboard, and what did you do when you wanted to connect one subscriber with another?" we asked, by way of beginning.

"Well, it wasn't a switchboard, in the first place—not in the modern sense. We called them switchboards, to be sure, but I am afraid that their recognition as such would be a hard job for the operator of today, who is accustomed to the multiple, common battery boards, with electric light signals. If you run through the records by these other early operators, you will see that there were almost as many kinds of switchboards as there were central offices. There were—"

May we interrupt Miss Schmitt at this point, before she is well started, to remark that we were well aware of the multiplicity of switchboard designs with which the struggling Bell companies were then trying to provide service? And thereby hangs a tale of one of the interesting phases of telephone development.

Theodore N. Vail had but recently joined the Bell organization and, from its office in Boston, was attempting to guide the development of the new business as best he could. The Bell Company had few facilities for experimentation and none for centralized manufacture. This condition resulted, as Dr. Frank B. Jewett has said, in a state of things in which "every little shop equipped to manufacture telephone apparatus immediately entered the field of production and applied the inventive genius of its own staff to the task of development."

Yet this development was not quite so chaotic as it seemed. Behind it there was a fundamental principle which Vail had laid down in a letter to H. W. Pope, written in June, 1879, which has become one of the historic documents of the telephone service. In it he had said: "What we want to do in every case is to adopt the best system, and that we think we have. Then if there is anything better we should of course want to adopt that."

Improvements, or what were believed to be improvements, were being made in dozens of places all over the country. The name of switchboard inventors was legion; the types of switchboard even more numerous for many types were put out under the name of the same designer or manufacturer. There was one Law type board, used in Richmond, Va., among other places, which was pyramidal in shape. Another Law type board consisted of a square table, on which connections were made by sticking pegs into holes on its surface. When traffic was heavy, the operators who sat at such a table gave somewhat the impression of a particularly fast and furious game of cribbage—with the cards left out.

There was the Gilliland board, which had something of the appearance of the modern switchboard, but which on close examination more nearly resembled an old-fashioned parlor organ. Later, there was a board which, because of a depressed trough behind the keyboard, which permitted mounting the

line signals below the plug shelf, was known by the expressive if not elegant name of the "hog-trough" switchboard. There were many others—but why continue? Let us ask Miss Schmitt to go on with her interrupted description of the equipment in the old Nassau office, as it was in 1882.

How One Central Office Looked

"Our office," Miss Schmitt explains, "consisted of a long, narrow room with apparatus at each side. At the middle of one end of the room stood the manager's desk. On one side was what we called the 'case.' Here, drops bearing the subscribers' numbers, in groups of 100 or fractions thereof, were arranged on upright panels. The case operator received the incoming calls, but did not complete them. The subscriber rang in by turning a crank, and the annunciator associated with his line dropped. The case operator took from him the number he wished to call, wrote it on a slip of paper, which she stuck on a pin-file conveniently placed on the board. These slips were collected by messengers, who carried them to the "trunk table" operators. The trunk tables were what their name implied—tables at which trunk lines were terminated. Each table was about the size of a present-day sewing machine and was equipped with eight or ten brass strips, each strip being the termination of a trunk line. To enable the operator to connect with a trunk, a brass plug attached to a cord was provided. This plug was held in the operator's right hand, and the receiver in the left—we had no headsets in those days. In making a connection, the plug was passed under the trunk strip, thus raising the strip and connecting the plug with the trunk. The great feat, however, was to connect the subscribers' lines with the trunk lines. When I first went to work in the old Nassau office, and for some time afterward, boys known as switchmen were employed for this purpose.

"When the trunk table operator received a ticket from the case operator, she proceeded to connect the calling subscriber

with the trunk line to the called office. This she did with the assistance of a switchman, to whom she passed the call—as, for example, '463 on 41.' On the board in front of the switchman all local lines were terminated, so that he could switch the calling subscriber's line to the line of the called subscriber or, in the case of a call to an outside office, to a trunk, as directed by the trunk table operator.

"When the trunk table operator found that the conversation was completed, she cleared the connection by calling out 'Clear 41.' When he was not busy doing something else, which he generally was, the switchman then disconnected the two lines. If the switchman's response to the requests of the operator was not reasonably prompt, she had to repeat it, in louder tones. Life in a central office in those days was a case of the 'survival of the fittest'—the operator with the most lung power got things done."

Miss Schmitt's description of the switching apparatus at which she made her telephone debut tallies quite closely, in essentials, with those of other operators who at the same time were working in Boston, Chicago and other cities. The Chinnock switchboard was installed in the Nassau office, in New York, in 1879, but had undergone some changes by 1882, when Miss Schmitt became an operator. The Williams board was used in New England, the Gilliland and Post boards in the Middle West, but also in New England and in Canada, and the Law boards in the South and Southwest.

On the Gilliland, Post and Williams switchboards, the connections between lines were not established by means of cords and jacks, as was the case with the Chinnock board described by Miss Schmitt and all later switchboards, but rather by brass plugs inserted in rows of crossing metallic strips or lines laid out in checkerboard fashion.

In 1880, the Western Electric Manufacturing Company brought out what was known as the "Standard" switchboard,

which in design and general arrangement was a forerunner of the boards later adopted throughout the Bell System. The switchboard described by Miss Schmitt, however, seems to have marked a partial advance toward the present-day manual switchboard, in that its "case" was similar, in purpose and function, though not in form, to the modern "A" board, while its "trunk table" was an embryonic form of the "B" board of today.

Steps in the Switchboard's Evolution

Other steps in the evolution of the modern switchboard included such outstanding developments as that of the multiple board, the first complete installation of which was made in 1882; the use of the metallic circuit and the adaptation of switchboards to it, which began in 1887; the introduction of the common battery principle, first applied to a multiple board in 1896; and the use of incandescent electric lights, instead of annunciators, for signaling purposes, which was inaugurated in 1894. All of these steps, Miss Schmitt and many other pioneer operators personally witnessed as they were taken—witnessed, and took part in them, for though scientists and engineers planned these improvements in apparatus and put them into effect, it was the woman at the switchboard who gave them their final stamp of approval. If she had not been able to operate them successfully, they would have been flat failures.

"You see," says Miss Schmitt, "as one looks back on all these years of switchboard development, from the operator's standpoint, one sees that they were intended for just one primary purpose—to make it possible for the operators to do their work more easily, more quickly and more accurately. It was a part of the Bell System's policy of giving the best possible service it can give. But it was also part of its policy—and I think it is an equally fundamental policy—of making it possible for its employees to give the best there is in them to the service.

Call it 'giving the operators a fair break' or what you will, it was a policy to which we responded. The more convenient the apparatus which we were given to work with, the better we worked. The more efficient it was, the more efficient we became."

"Not without being taught, did you?" we asked, for we were anxious to hear what Miss Schmitt had to say about early methods of training operators for their work.

But that, as Kipling might say, is another story.

R. T. BARRETT

(To be Continued)

The Effect of Immigration on Population Growth and Character

A THIRD of the population of the United States are immigrants or the children of immigrants. Naturally any changes which affect this class of people have a profound influence upon the growth and characteristics of the population of the country, and are of interest to the telephone industry in connection with appraisals of the potential demand for its facilities and services.

Since the World War the interchange of peoples between countries has been vastly altered. The stream of immigration to the United States has diminished to a mere trickle; today deportations and voluntary departures actually exceed arrivals, apparently for the first time in our history. Furthermore, our attitude toward the alien has changed from one which welcomed him with open arms on the assumption that our shores offered an asylum to the oppressed of the earth, to one which discourages his coming almost to the point of complete prohibition. An understanding of these and related changes is essential to any consideration of the future composition of the population of the country.

Historical Review of Immigration

During our national history, governmental agencies have recorded about thirty-eight million immigrants admitted through regular channels, while perhaps as many as five million additional foreign-born entered this country in times when alien movements were either imperfectly counted or not recorded at all, particularly migrations over our land borders. The five million would also include a small allowance for aliens who entered illegally.

During the first hundred years of our history as a nation, immigration was free from legal restrictions; in fact, in the initial four decades no attempt was made even to count the incoming aliens. Following this, for forty years the only restrictions imposed were of a qualitative nature, designed to exclude certain undesirable classes. However, the past fifteen years have reflected a definite attitude toward restricting the admission of foreign-born on a numerical basis, and this policy has been more pronounced since the beginning of the depression.

Until this recent period when quantitative restrictions became effective, the flow of immigration was largely influenced by economic conditions here and abroad. The first really notable influx occurred about 1850 and was due largely to famine in Ireland and to political revolution in Germany. Successive waves of immigration tended to increase in volume; they reached peaks of 1,285,000 in 1907 and 1,218,000 in 1914, with troughs during the Civil War and the depressions of the 'seventies and the 'nineties. The World War practically closed the flood-gates in Europe until in 1918 immigration declined to the lowest level since 1862. Since 1921 the volume of European immigration has been controlled by our restrictive policy and variations in immigration other than that from quota countries were due entirely to movements from Canada and Mexico. Actually the heavy migrations from Canada and Mexico to the United States from 1920 to 1930 were merely part of the general rural to urban movement which took place all over the country during that decade.

During the first century of our immigration history, the great bulk of immigrants came from the United Kingdom and Germany; the countries of northern and western Europe furnished over 70 per cent of the total immigration as late as 1882. From that time until the World War an increasing proportion of immigrants came from southern and eastern Europe, until

they accounted for over three-fourths of all immigration and four-fifths of the number from Europe.

During the past 27 years as a whole, emigration has amounted to about one-third of total immigration and, with the exception of a few years when unusual conditions prevailed, it has not varied much year by year from this relationship to the inward movement. No governmental data on emigration are available prior to 1908, but steamship company records of the outward movement of aliens indicate that it was of minor importance.

Immigration Legislation and Policy

The first inclusive Federal immigration law was enacted in 1882. It denied admission to lunatics, persons likely to become public charges, convicts (except those convicted of political offenses), and the Chinese race. There was later added to the excluded classes the natives of other Oriental countries, physical defectives, criminals and immoral persons, contract laborers, and illiterate aliens. All these restrictions, however, were primarily qualitative and did not affect the numerical influx of the foreign-born.

The passage of the per centum quota law in 1921 marked the beginning of a policy which restricted immigration on a numerical basis. This law provided that "the number of aliens of any nationality who may be admitted under the immigration laws to the United States in any fiscal year shall be limited to 3 per cent of the number of foreign-born persons of such nationality resident in the United States, as determined by the census of 1910." This limited the total number of quota immigrants from Old World countries to 357,800 per year. Aliens were exempt from the quota provisions after one year's residence (raised to five years in 1922) in a country of the New World.

Nationality under this law was determined by country of birth, and each country had its own quota. Countries of

northern and western Europe which, during the period immediately before the passage of the law, had been furnishing only about 20 per cent of the immigration from Old World countries were given quotas aggregating 55 per cent of the total. The law thus represented not only a radical change in our immigration policy in regard to the number which could be admitted, but was a deliberate attempt to confine our immigration largely to those nationalities which were considered most assimilable.

The Immigration Act of 1924 supplanted the so-called quota limit act of 1921 and included several important changes. The annual quota of each Old World country was immediately lowered to 2 per cent of the population of such nationality resident in the United States in 1890 instead of 3 per cent of that in 1910. The total of all quotas under the Act of 1924 amounted to 164,667, a reduction of about 193,000 from the number admissible under the Act of 1921. Most of this reduction occurred among aliens native to southern and eastern Europe. Another change provided that the quotas should apply to natives of Old World countries residing in American countries regardless of their length of residence there. Otherwise the classes exempt from the quota were about the same as those under the 1921 law.

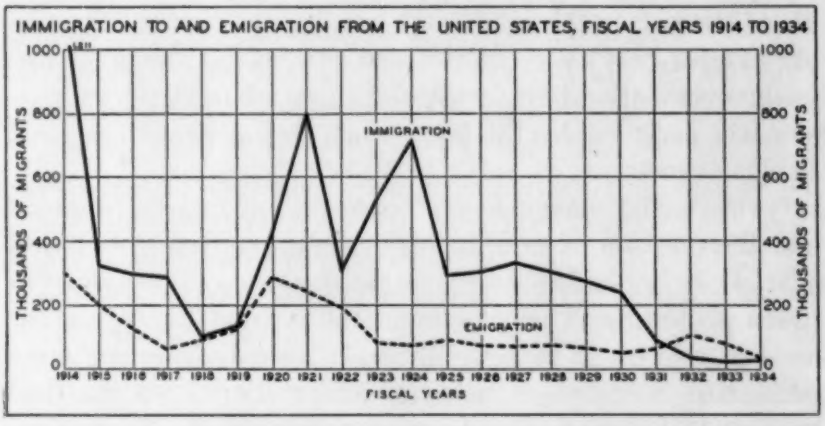
The Act further provided for a determination of the national origins of the population of the country as of 1920 by specifying that "the annual quota of any nationality shall be a number which bears the same ratio to 150,000 as the number of inhabitants in continental United States in 1920 having that national origin bears to the total number of inhabitants in continental United States in 1920; but the minimum quota of any nationality shall be 100." The effect of this provision, which became effective on July 1, 1929, was merely to change somewhat the quotas without changing the general working of the immigration law. The decreases in quotas were largely cen-

tered in northern continental Europe and Ireland and the principal increases occurred in Great Britain.

The Immigration Act of 1924 introduced a radical departure from the previous immigration policy in providing that American consuls, assisted by technical advisers of the Immigration Service, should examine abroad prospective immigrants under all provisions of law, and refuse visas to those deemed inadmissible. The inauguration of this practice permitted a certain degree of selectivity of aliens in their home countries, resulting in a higher standard of quality and a smaller percentage of rejections than previously. Moreover, when the economic depression came along this practice facilitated the enforcement of the provision designed to safeguard the United States from immigrants who might become public charges.

Volume, Source, and Character of Recent Immigration

Many of the most striking changes in the immigration tide have taken place during the past two decades and in the following discussion principal attention will be directed to the more important aspects of the alien migrations of this period.



The accompanying chart discloses several significant facts concerning the trend of immigration and emigration during the

past twenty years, notably the relatively large outward movement during the early years of the World War, which included many who went to join the colors of their respective countries; the sudden increase in both immigration and emigration following the armistice; the sharp decline of immigration in 1922 resulting from the quota limit law; the revival of immigration in 1923 and 1924 (largely from Canada and Mexico) and the remarkable decline in emigration; the drastic drop in immigration in 1925 resulting from the new quota limit law; and, finally, the further sharp reduction in immigration since 1930 to a point where emigration has exceeded immigration since 1931. During recent years the strict interpretation of the provision of the immigration law requiring the exclusion of persons "likely to become a public charge" has greatly reduced the number of consular visas issued to prospective immigrants.

One element frequently overlooked in ordinary calculations of population movements is the migration of United States citizens who permanently depart this country. This population loss has amounted to over 600,000 during the past seventeen years and probably would more than offset any gains from illegal entrants in this period. A small proportion of this number (11 per cent) were naturalized citizens but the great majority were native born, mostly children of foreign-born parents who accompanied the latter when they emigrated to some foreign country.

Owing to the changes in the boundaries of various countries and the creation of new countries resulting from the World War, it is impossible to make satisfactory comparisons between post-war and pre-war immigration from Europe on the basis of country of origin. Table 1, however, presents some interesting comparisons between immigration from specified sections of Europe and from other sources in the fiscal years 1914, a fairly normal pre-war year in the matter of immigration into the United States; 1921, a post-war year during which

there was no numerical limit on European immigration; and subsequent years when various quota limit laws were in force. It will be noted that in 1914 and also in 1921 a large majority of our immigrants came from southern and eastern Europe. On the other hand, the contribution of northern and western European countries, while numerically greater than in any post-war year except 1924, was only 13.5 per cent of the total in 1914 and 17.2 per cent in 1921 as compared with an average of 35 per cent for the following 10 years. The increased volume of immigration from British North America and Mexico during the period of European restriction is also a noteworthy feature.

The effect of the quota limit laws of 1921 and 1924 on European immigration will become more apparent when the permissible and actual admissions under the restrictive legislation, as shown in Table 2, are examined. It should be borne in mind that in the quota law figures, country of birth rules, whereas country of last permanent residence is regarded as country of origin in ordinary immigration tables. Thus, immigrants admitted as Canadian residents who were born in England would be charged against the quota allotment for Great Britain. This provision, together with the fact that the quota limit laws contained a good many exceptions under which applicants could be admitted in excess of allotted quotas, accounts for the seeming inconsistency of the number of quota immigrants admitted from northern and western Europe from 1925 through 1931, as shown in Table 2, exceeding the corresponding number in Table 1.

In the five-year period following the passage of the 1924 quota, more than 92 per cent of the number allotted to all the principal European nationalities actually came to this country. And, as indicated in Table 2, the proportion admitted in the fiscal year 1930 under the national-origins plan did not differ much from the average of the five preceding years, the lower quota allottment under the 1929 law accounting for

TABLE 1

IMMIGRANT ALIENS ADMITTED, BY PRINCIPAL SOURCES, IN FISCAL YEARS SPECIFIED

Source	1914	1921	1922	1923	1924	Average 1925–1929	1930	1931
Northern and Western Europe*	164,133	138,551	79,437	156,429	203,346	121,828	97,118	34,719
Southern and Eastern Europe*	894,258	513,813	136,948	151,491	160,993	36,053	50,320	27,190
British North America	86,139	72,317	46,810	117,011	200,690	84,487	65,254	22,183
Mexico	14,614	30,758	19,551	63,768	89,336	48,634	12,703	3,333
Other Countries†	59,336	49,789	26,810	34,220	52,531	13,180	16,305	9,714
Total	1,218,480	805,228	309,556	522,919	706,896	304,182	241,700	97,139

* Northern and western Europe comprises Belgium, Denmark, France, Germany, Iceland, Luxemburg, Netherlands, Norway, Sweden, Switzerland, and England, Ireland, Scotland, Wales, and United Kingdom not specified. Southern and eastern Europe comprises the other countries on that continent.

† Includes Central and South America, Africa, Asia, Australia, Atlantic and Pacific Islands, and countries not specified.

TABLE 2

IMMIGRATION QUOTAS ALLOTTED TO SPECIFIED AREAS AND THE NUMBER OF ALIENS ADMITTED AND CHARGED AGAINST SUCH QUOTA ALLOTMENTS, IN FISCAL YEARS SPECIFIED

Country or Region of Birth	1921 Quota Law		1924 Quota Law		National-Origin Plan		
	Number Admissible Annually	Number Admitted 1924	Number Admissible Annually	Average Number Admitted 1925–1929	Annual Quota	Number Admitted	
						1930	1931
Northern and Western Europe	197,630	197,598	140,999	131,690	125,853	114,157	37,629
Southern and Eastern Europe	155,656	155,527	20,323	19,354	24,638	24,576	14,668
All other countries	4,517	4,517	3,345	1,278	3,223	2,764	1,821
Total	357,803	357,642	164,667	152,322	153,714	141,497	54,118

practically the entire difference in numbers. As a general rule, the large countries of northern Europe, such as Great Britain, Germany, and Ireland, have not come quite so near completing their quotas as have the smaller countries or the nations of southeastern Europe.

The fiscal years 1930 to 1934, inclusive, witnessed a drastic reduction in the volume of immigration. A more strict administration of the law was adopted in September, 1930; and the clause relating to the danger of becoming a public charge was interpreted so that the entrance of members of the working class was made almost impossible.

Another interesting form in which immigration statistics appear is the classification according to races or peoples. Since this record is based on the racial rather than the political or geographical status of admitted aliens, it is not affected by shifting political boundaries, newly created countries, or changed place of residence on the part of the aliens themselves. Moreover, several distinct racial groups often form the native population of individual countries, as, for example, Russia, where the racial composition of the immigrants who came to the United States during the five-year pre-war period, 1910–1914, was distributed according to the following percentages: Hebrew 36.6, Polish 33.9, Russian 14.5, Lithuanian 9.7, and Finnish 5.3.

Table 3 shows, for the principal racial groups, the number of immigrant aliens admitted to the United States during selected years. In 1914, a fairly typical pre-war immigration year, three-fourths of the immigrants admitted from all sources were of the varied stocks indigenous to southern and eastern Europe, and only one-fifth belonged to northern and western European peoples. In 1921, the first post-war year to witness a resumption of immigration to any considerable extent, the corresponding proportions were two-thirds and one-quarter. However, under the operation of the quota laws these ratios

TABLE 3

IMMIGRANT ALIENS ADMITTED DURING SPECIFIED YEARS, BY RACE OR PEOPLE

Race or People	1914	1921	1924	Average 1925–1929	1930	1931
Northern and Western Europe	253,855	206,995	393,342	204,251	161,444	56,354
English*	51,746	54,627	93,939	39,680	34,960	12,703
French*	18,166	24,122	48,632	19,942	13,771	4,908
German	79,871	24,168	95,627	55,853	34,415	13,813
Irish	33,898	39,056	42,364	39,795	34,947	10,814
Scandinavian	36,053	25,812	40,978	19,378	8,478	3,947
Scotch	18,997	24,649	61,327	25,090	28,117	7,618
All Others (Dutch, Flemish and Welsh)	15,124	14,561	10,475	4,513	6,756	2,551
Southern and Eastern Europe	901,659	521,474	187,709	42,286	56,604	31,598
Balkan races†	154,061	63,338	23,389	5,632	6,938	3,309
Greek	45,881	31,828	5,252	2,177	3,793	2,663
Hebrew	138,051	119,036	49,989	11,232	11,526	5,692
Italian	296,414	222,496	59,209	14,604	23,316	13,970
Magyar	44,538	9,377	7,446	1,093	1,542	999
Polish	122,657	21,146	19,371	3,670	4,924	2,008
Russian	44,957	2,887	9,531	1,203	1,634	967
All Others (Finnish, Lithuanian, Portuguese and Spanish)	55,100	51,366	13,522	2,675	2,931	1,990
Mexican	13,089	29,603	87,648	47,705	11,915	2,627
All other races and people	49,877	47,156	38,197	9,940	11,737	6,560
Total	1,218,480	805,228	706,896	304,182	241,700	97,139

* Includes considerable numbers entering United States from Canada.

† Natives of Czechoslovakia, Bulgaria, and Yugoslavia including Bohemian, Bosnian, Bulgarian, Croatian, Dalmatian, Herzegovinian, Montenegrin, Moravian, Serbian, Slovak, and Slovenian.

were reversed, and since 1921 the peoples native to northern and western Europe have been greatly in the majority.

In fact, one of the most significant effects of the quota laws has been the greatly increased proportion which the English speaking peoples—English, Irish, Scotch, and Welsh—formed of the total number of immigrant aliens admitted during the latter part of the 1920–1930 decade as compared with the pre-war period. In 1914 only 9 per cent of the total immigration was composed of English speaking peoples, while by 1924 this proportion had increased to 28 per cent; and for the five-year period 1925–1929 it averaged 35 per cent, finally reaching 42 per cent in 1930.

The Net Result in Population Growth

During the past two decades the foreign-born population increased by only 688,000, or 5 per cent, as compared with 4,266,000, or 46 per cent, during the 1890–1910 period. Expressed in different terms, the foreign-born contributed only 2 per cent of the total population growth between 1910 and 1930 as against 15 per cent during the preceding 20 years.

Since the 1930 census a net outward migration of foreign-born has taken place, amounting to about 100,000 in this five-year period. Furthermore, with net immigration at a comparatively low average level during the last twenty years, the majority of our alien population is now becoming well advanced in years, and consequently its total death rate is high. (Table 4 shows how much the average age of the foreign-born increased between 1910 and 1930.) It is believed that the combined losses in foreign-born population during the present decade from net emigration and deaths should amount to about 3,500,000, thereby reducing its proportion of the total population from 12 per cent in 1930 to 8 per cent in 1940.

Associated with the increasing age of the foreign-born is the declining birth rate. The 1930 census showed 1,500,000 fewer children under ten years of age of foreign parentage

than did the 1920 census. This slackening in the increase in the second generation of foreign white stock is clearly indicated by the figures in Table 4 which show that this population group in 1910 was younger than the native white of native parentage, but was distinctly older than the latter in 1930.

TABLE 4

PERCENTAGE DISTRIBUTION OF POPULATION BY AGE; 1910, 1920 AND 1930

Age Group	Native White of Native Parentage			Native White of Foreign or Mixed Parentage			Foreign Born White		
	1910	1920	1930	1910	1920	1930	1910	1920	1930
Under 5 years	13.2	12.6	11.3	14.1	13.1	7.7	0.8	0.3	0.2
5 to 14 years	22.6	23.0	22.6	24.1	24.4	21.2	4.9	3.6	2.0
15 to 24 years	19.7	18.5	19.0	21.6	18.8	21.0	15.8	10.7	7.4
25 to 44 years	26.2	27.0	27.2	27.6	27.1	29.3	44.1	45.7	41.8
45 to 64 years	13.6	14.1	15.0	11.2	14.3	16.3	25.4	29.8	36.1
65 and over	4.6	4.8	4.9	1.4	2.3	4.5	9.0	9.8	12.5

Even among the foreign-born population there are pronounced differences in rates of growth, especially among the natives of European countries. For example, it appears from Table 5 that the proportion of foreign-born and their children from the "old" immigration countries—principally Germany, England, Ireland, and Scandinavia—is still decreasing, notwithstanding the fact that movement from these countries is favored by the new quotas. This is due to the fact that the large proportion of these nationals have been in this country so long that their death rate is high. On the other hand, there is a lower death rate in the more recently arrived groups (from southern and eastern Europe) which for the present compensates for their decreased proportion of quota immigration. Another decade of restricted immigration will, however, probably destroy this differential.

The older immigrant groups naturally increase more slowly than the more recent arrivals who include a larger proportion of young people and who also are from countries with a higher

TABLE 5

FOREIGN BORN WHITE STOCK IN THE UNITED STATES, BY REGION OF BIRTH OR ORIGIN; 1910, 1920 AND 1930

Region of Birth or Origin	European Born White Population			Native Whites of European or Mixed Parentage		
	1910	1920	1930	1910	1920	1930
Europe						
Southern and Eastern (New)	5,238,495	6,363,022	6,407,272	3,407,827	6,756,202	9,316,090
Northern and Western (Old)	6,548,858	5,514,978	5,335,613	13,581,865	13,657,555	13,619,420
Per Cent Distribution						
New immigration	44.5	53.6	54.6	20.0	33.0	40.6
Old immigration	55.5	46.4	45.4	80.0	67.0	59.4

birth rate than the countries sending the bulk of the immigrants before 1900. The figures in Table 5 reflect the fact that the second generation of the older groups has remained stationary, while that of the newer immigration is rapidly becoming an important element in the population. This is ascribable in part to the increased age of the earlier migrants and in part to the higher birth rates among the new immigrants. There is some evidence that the immigrants from countries with a high birth rate continue to maintain a high birth rate in this country.

Geographical Distribution of Immigrants

The destination of newly arrived aliens is indicated by their declaration regarding the state of their intended future permanent residence. In general, the vast majority of immigrants have settled in the more densely populated and industrial sections of the country. The presence of relatives or friends in these states with a great alien population served as an added attraction to newcomers to settle there. The states which had about three-fourths of the foreign-born population in the United States in both 1920 and 1930 received four-fifths of the total immigration during the past twenty years.

Ten states, all except two of which are located in the northeastern section of the country, averaged nearly 24,000 immigrants per state per year during the past twenty years, while by contrast twenty-five other states, all in the South and the West, averaged only 600 immigrants per state per year; moreover, in this period these twenty-five states together totalled only slightly more immigrants than the corresponding figure for New Jersey alone. The contrast between these two areas is more sharply defined when it is noted that during the past twenty years the ten highest states received twice the net immigration needed to replace the deaths among their foreign-born population and consequently have experienced a substantial gain in this class since 1914, while on the other hand

the net immigration to the twenty-five lowest states was only about one-third of the deaths among their alien population, with the result that they sustained a heavy net loss in this class of population.

Occupational Status of Immigrants

There are striking changes in the previous occupations of immigrants between those entering during the period 1911–1914 and those entering during the period 1925–1930. The former reflect conditions before the war and the quotas, and the latter conditions after rigid legal and administrative restrictions had been put into practice. The small proportion of professional people was more than tripled in the later period. This was to be expected, as the law of 1924 placed ministers and professors in a non-quota class. Shutting off the flow of immigration from southern and eastern Europe has also resulted in an increase in the proportion of entrants who are in the skilled class, with a corresponding decrease in the propor-

Occupational Status of Immigrants Admitted

	Number		Per Cent	
	Average 1911–1914	Average 1925–1930	Average 1911–1914	Average 1925–1930
Professional	12,948	10,640	1.7	6.1
Skilled	152,306	54,260	20.0	30.9
Unskilled	567,196	93,964	74.7	53.5
Farmers and farm laborers	253,323	29,038	33.4	16.5
Common laborers and servants	313,873	64,926	41.3	37.0
Commercial	14,995	5,445	2.0	3.1
Miscellaneous	12,215	11,171	1.6	6.4
Total with occupation	759,660	175,480	100.0	100.0
No occupation	273,624	118,265	26.5	40.4
Grand Total	1,033,284	293,745	—	—

portion of the unskilled. When the unskilled class is further divided into farmers and farm laborers, and common laborers

and servants, it is found that the proportion of the former has decreased by over one-half, in spite of the quota preference given to farmers. Common laborers and servants, however, continued to enter in almost the same relative volume. Of the total immigrants admitted, there has been a decided increase in the proportion with no occupation, which is to be expected considering the larger number of women and children who have entered in recent years.

Illegal Entry of Aliens

The surreptitious entrance of foreign nationals into the United States by the variety of methods employed to evade legal restrictions has received a degree of publicity seemingly disproportionate to the probable magnitude of this unlawful migration.

Alien smuggling has been a most troublesome phase of the immigration problem ever since the enactment of the first Chinese exclusion law, and for a good many years such operations were largely confined to bringing aliens of that race into the country. With the development of the general immigration law, however, the practice spread to other aliens of the diseased and otherwise inadmissible classes, and, as the law became more complex, the prevention of smuggling and surreptitious entry by other means became correspondingly difficult.

Closely allied to border running is the illegal entry of alien seamen who come to United States ports as members of ships' crews and, taking advantage of shore privileges granted under the law, desert the vessels bringing them and remain in the country. During the past twenty years about 220,000 alien seamen were reported to have deserted their ships, with the peak of 35,000 in 1924 coinciding with the drastic quota law restrictions. During recent years the number has declined rapidly from 9,100 in 1930 to only 664 in 1933 and 972 in

1934, reflecting the diminution of employment opportunities in this country.

The organization in 1925 of a land-border and sea-coast patrol of 450 men (gradually strengthened to 984 in 1932) to supplement the regular immigration inspection forces provided for more adequate protection of the international boundaries than was possible previously; and the deterrent effect exercised by the patrol has been a most important factor in keeping alien smuggling efforts and other illegal activities along the borders within bounds.

The causes for the deportation of aliens to their native countries have steadily increased in number during recent years, and the time within which aliens are subject to such regulations has continued to lengthen. Moreover, successive immigration laws have become more rigorous in their provisions for exclusion and the penalties for violations have become more severe. Thus the threat of imprisonment, fine, and deportation tends to deter surreptitious entry of aliens and frighten away those who are already here illegally. The number of aliens deported has increased steadily since the quota law went into effect, rising from 3,661 in 1923 to 19,865 in 1933. As a result of the depression, activity in the removal of aliens illegally resident in the United States has been greatly stimulated in recent years.

Summary

During the first hundred years of our recorded immigration history, when there was no numerical limitation, 92 per cent of all aliens admitted to this country came from Europe, whereas during the succeeding 10-year period (1922–1931) the quota laws restricted European immigration to only 56 per cent of the total number. Moreover, the European stream has shown wide variations in its national composition. Prior to 1880, seven out of every eight European immigrants came from northern and western nations—Belgium, France, Germany,

the Netherlands, Scandinavia, Switzerland, and the United Kingdom—but during the following forty years the pendulum swung the other way, with 60 per cent coming from other European countries, comprising Austria, the Balkan States, Greece, Hungary, Italy, Poland, Portugal, Russia, Spain and Turkey. Finally, the result of the quota laws effective during the past decade was not only to reduce very materially the proportion of immigrants coming from Europe but also to turn the tide in favor of the old sources again, the northern and western countries accounting for five out of every eight immigrants from Europe between 1922 and 1931.

As a result of immigration influences, the racial character of the United States has undergone radical changes in the past twenty years. Up to 1914 the country was becoming more heterogeneous owing to rapid immigration and the spread of aliens into communities theretofore populated almost wholly by native Americans. Since 1914 the most striking development has been the marked diminution of European immigration, due to various factors; first the war, then statutory laws, and finally the depression. Back of the legal limitations on immigration has been a change in national sentiment regarding America as a refuge for all people and an effort to arrive at a restrictive policy.

Several factors contributed to a reversal of sentiment regarding the open-door policy about 1920, among the most important of which were the reduced need for foreign labor and the shift of European immigration from countries of Northwest Europe to Russia and the countries of Southeast Europe—a shift which naturally tended to create increasingly difficult problems of assimilation.

In volume of growth alone, the change has been far-reaching. The reduction from an average annual immigration of nearly 1,000,000 during the first fourteen years of the Twentieth Century to a corresponding figure of only 290,000 in the following 20-year period does not entirely measure the shrink-

age, for these foreign born had the highest birth rates of any nativity class in the population and by restricting their numbers the natural increase has also been slackened. On the basis of the trends in immigration in addition to those of births and deaths, it is possible to predict that if the present immigration situation continues and the present mortality rates continue, the number and proportion of foreign born in the population will markedly decrease. Later the proportion of children of immigrant parents will decline. These changes will tend to produce a more homogeneous population in which the native element will increasingly predominate.

R. L. TOMBLEN

Notes on Recent Occurrences

DR. JEWETT RECEIVES AWARD OF FARADAY MEDAL

ANNOUNCEMENT was made in London, England, on January 25, that the Council of the Institution of Electrical Engineers had unanimously voted to award the Faraday Medal for 1935 to Dr. Frank B. Jewett, Vice President of the American Telephone and Telegraph Company and President of the Bell Telephone Laboratories.

The practice of awarding the medal, which was instituted in 1922, had as its object the commemoration of the fiftieth anniversary of the first meeting of the Society of Telegraph Engineers, which later became the Institution of Electrical Engineers. Under the terms of the resolution establishing the award, the medal may be awarded not oftener than once a year "either for notable scientific achievement in electrical engineering, or for conspicuous services rendered to the advancement of electrical science, without restriction as regards nationality, country of residence or membership in the Institution."

The medal is of bronze. At the time of its establishment, it was announced that it was desired by the Institution that "there should be no suggestion of any intrinsic value in the medal itself, but rather that it should owe its value, first, to the fact that it was to commemorate an important event in the history of this Institution; secondly, that it was offered for world-wide services without any restrictions; and lastly, that it was hoped, as time proceeded, its importance would be advanced by the illustrious names of its holders."

The medal has been awarded each year since 1922, with the exception of 1933. The recipients of the award have been:

Oliver Heaviside, Sir Charles Parsons, Dr. S. Z. deFerranti, Sir Joseph John Thomson, Col. Rookes Evelyn Bell Compton, Elihu Thomson, Sir J. A. Fleming, Guido Semenza, Lord Rutherford, Charles H. Merz, Sir Oliver Lodge, Sir Frank E. Smith, and Dr. Jewett. Of these, Elihu Thomson and Dr. Jewett are the only representatives of the United States.

MICHAEL PUPIN, INVENTOR OF THE LOADING COIL, IS DEAD

(The following article was written for Bell System employee publications by President Frank B. Jewett of the Bell Telephone Laboratories.—Ed.)

BECAUSE of his prominence for many years in the fields of science and engineering, and particularly in the field of electrical communication, the announcement of the death on March 12 of Dr. Michael I. Pupin of Columbia University is a matter of deep regret to a large number of telephone people.

While never officially connected with the Bell System, Dr. Pupin had for more than thirty-five years played an important part in the development of the Bell System. His invention of loading as a means of greatly extending and improving the transmission characteristics of open wire and cable circuits was a vital factor in the development of a comprehensive nation-wide telephone system. The American Telephone and Telegraph Company purchased Dr. Pupin's patents on this invention at the time of their issuance. This outstanding invention raised Dr. Pupin to the front rank of scientific men and brought to him recognition from all parts of the world.

Although the loading invention was unquestionably the principal of Dr. Pupin's contributions to the art of electrical communication, it was not by any means his only contribution. Particularly in the field of high frequency transmission, both by wire and by radio, Dr. Pupin's work added notably to progress.

Throughout the many years of his contact with the scientific work of the Bell System, Dr. Pupin contributed in many ways

which were not and could not be measured in terms of concrete things. The close personal friendships which were established between him and the late General Carty, Mr. Gherardi and Dr. Jewett were valuable in the opportunity which they gave to partake of his wise counsel and advice. Nor was this counsel confined wholly to matters of science and engineering, for Dr. Pupin was a man of great wisdom and force in many matters.

He was endowed with a lovable disposition which impelled him always to extend help where he could. This was particularly noteworthy in his attitude toward young men. It was his boast that his greatest achievements were not the results of his scientific work but were his discovery and training of men who later attained to eminence.

In his death the Bell System has lost an ardent and steadfast supporter of its work and its policies, and many of its members individually have lost a cherished friend.

BELL SYSTEM TO EXHIBIT AT CALIFORNIA EXPOSITION

AT San Diego during the coming summer will be held the California Pacific International Exposition. In that exposition the American Telephone and Telegraph Company will have an exhibit on behalf of the Bell Telephone System. It will be located on a corner of the main plaza and the central avenue through the exposition grounds. It will be in effect an independent building on the street level, with an entrance at the corner, and large arched windows on either side through which the passer-by may get a view of the exhibit area.

The exhibit will center on the concept of the "telephone voice," with three demonstrations. One will be an oscilloscope permitting a visitor to see the wave form of his own telephone voice. Another will allow him to hear over the telephone exactly how his voice sounds to others when he is telephoning them. The third exhibit is a demonstration of inverted

speech, showing how privacy is introduced into radio telephone conversations and the peculiar and unintelligible sounds which represent a radio telephone message in transit over the ocean.

Like the 1933 Century of Progress exhibit in Chicago, the one at San Diego is under the general direction of Vice President A. W. Page of the American Telephone and Telegraph Company, and Dr. F. B. Jewett, President of Bell Telephone Laboratories. Its design is being carried out in the Laboratories under the direction of John Mills, and its technical features are being arranged by M. B. Long. The operating staff will be recruited from the forces of the Southern California Telephone Company, and the manager of the exhibit during operation will be Paul L. Johnson of that company.